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Brief version of the Conversio study

Material flow analysis plastics in Germany 2021: Facts and figures on the life cycle of plastics



Publishers



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- B. Summary of the main results
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- E. Plastic waste and recycling, by-products and its reuse

Target, definition, structure and basis of the project

Aims and areas of investigation of the study

The collection, documentation and publication of production and converting data, also including the recycling, are an important instrument for obtaining a continuous picture of the development of the plastics segment in **Germany**.

Because of the importance in both the public sector and the economic sector and because of the demand for such information, this study is carried out every two years. The data and facts given here relate to the year 2021.

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

- Production, converting and consumption of plastics and plastic products
- Waste generation and recycling
- Plastics recycle and by-products and their fields of application

Broad consensus and support of the plastics industry

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

The **period covered by the survey** was from March to July 2022.

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-set questionnaire.

- **Plastics converters/plastics recyclers**

For the plastics converters 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 360 companies took part in the survey.

- **Questioning of experts**

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

- **Further information sources**

- Evaluation of production statistics
- Import/export statistics, e.g. Eurostat, Destatis
- Association statistics, GVM data etc.
- Internet research

New content as part of the present study

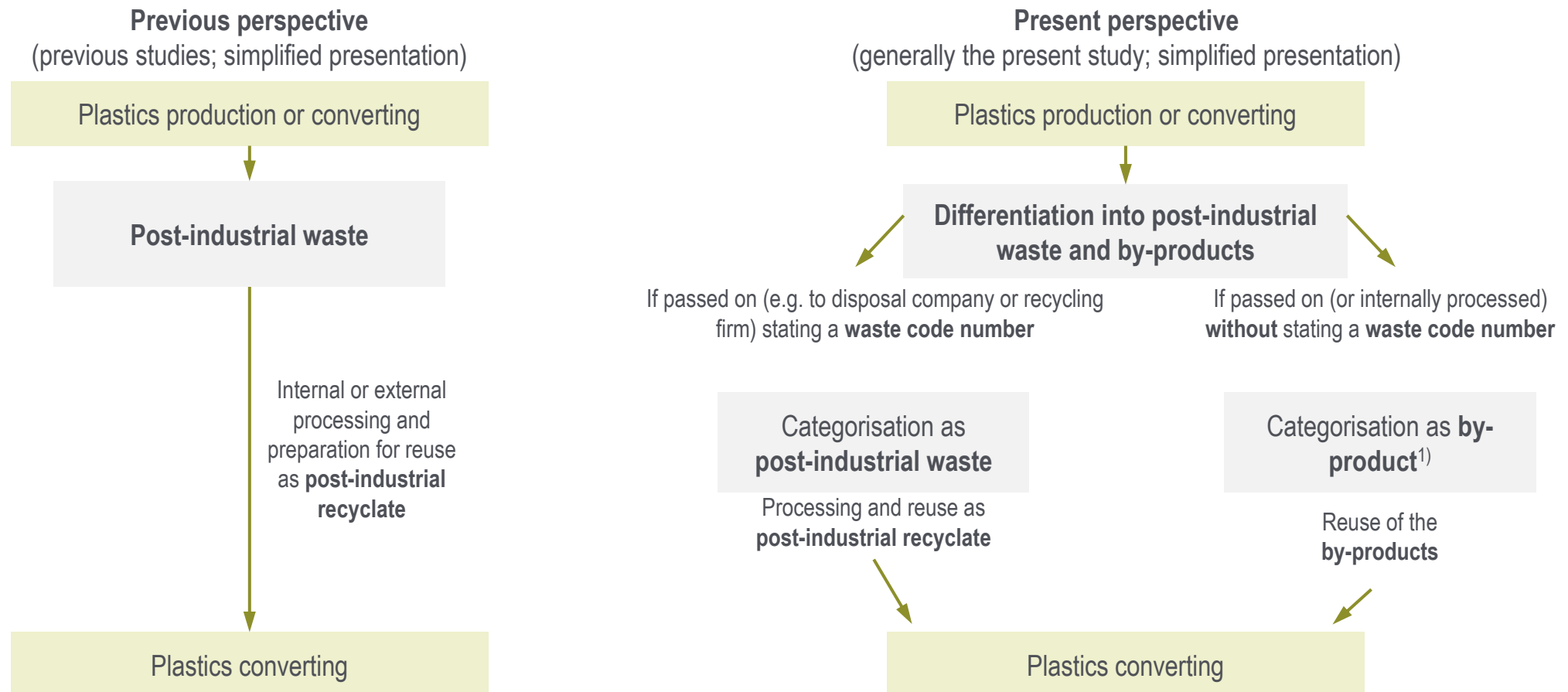
By-products and plastic waste from the production and converting process: Explanations

- In the present study, a distinction is made for the first time between post-industrial waste and by-products from the production and/or converting process within the meaning of para. 4 Kreislaufwirtschaftsgesetz (i.e. the German waste management act). Accordingly, the present study differentiates between waste and by-products both with the material flows and with the products resulting from the recycling of waste (recyclate) and the utilisation of by-products.
- The corresponding categorisation was made on the basis of the documentation of quantities by means of waste code numbers:
 - If the material concerned was passed on to e.g. a disposal company or treatment operator, stating the waste codes, this material is categorised as "waste".
 - If the material concerned was passed on without a waste code (or in the event of separate internal treatment, e.g. in the converting plant itself), the material is categorised as "by-product".
- Consequently, a distinction is made between ...
 - Recyclate production from material flows of post-industrial waste (produced by the converting of post-industrial waste with waste code number) and ...
 - The use of by-products (without waste code number)
- The comparability of the total quantities utilised from the post-industrial field with the quantities shown in the previous studies (up to reference year 2019) thus remains. The field of post-consumer waste and the use of recyclate from post-consumer waste, respectively, remains unaffected.

New content as part of the present study

By-products and plastic waste from the production and/or converting process: Overview of the previous / present perspective

The following overview explains the previous and present perspectives of post-industrial waste and by-products :



¹⁾ See also definition for by-products as per para. 4 Kreislaufwirtschaftsgesetz (German Waste Management Act)

New content as part of the present study

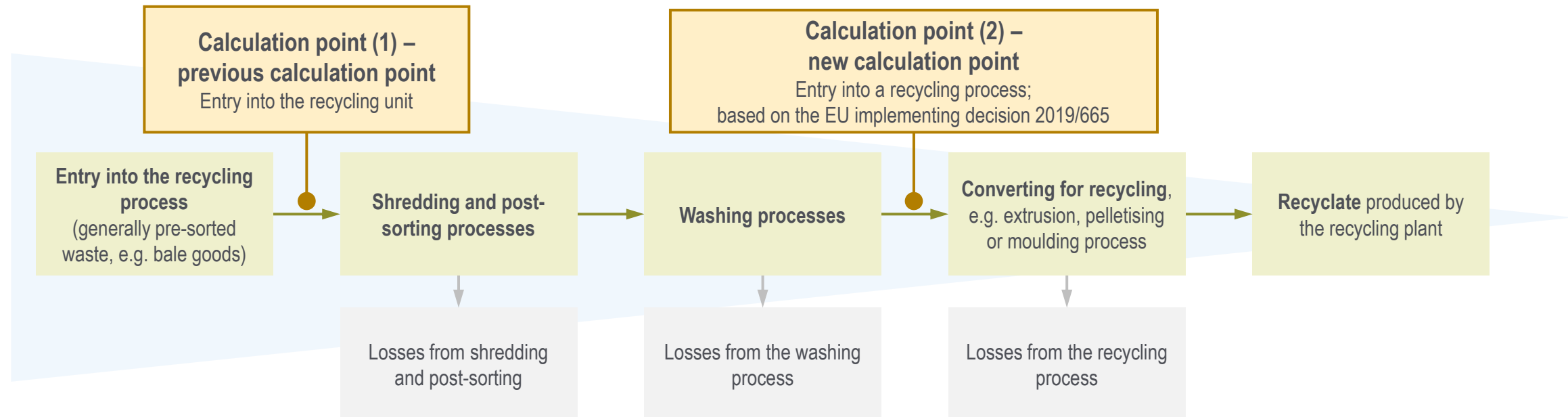
New calculation point for recording recycling volumes in the recycling process

- The calculation of the recycling volumes for 2021 is carried out on the basis of the EU implementing decision 2019/665 in the packaging segment. This is in the context of the EU packaging directive 94/62/EG (PPWD) and EU decision 2005/270/EG. The Packaging and Packaging Waste Directive (PPWD) has expressly provided for the corresponding implementation acts. They enable the Commission – under the supervision of the committees with representatives of the EU countries – to create conditions for the uniform implementation of EU legal regulations. Basically, the resolution is thus legally binding throughout the EU. The implementation practice in Germany including data collection by the GVM (Society for Packaging Market Research) is documented by the Federal Environmental Agency (source: UBA texts 148/2021).
- In the previous studies (up to reference year 2019) recycling volumes were calculated and shown in accordance with their arrival at the recycling plant, i.e. after calculation point (1), see diagram on next page. As the basis for recording recycling volumes after calculation point (1), use is made of the volumes fed into the recycling plant.
- The present study with reference year 2021 also shows recycling volumes after calculation point (2) in accordance with the EU implementing resolution as part of the calculation procedure according to Article 6 of the PPWD, see diagram on next page. Calculation point (2) for *"Plastics as packaging material"* is thus described as follows: *"Plastics separated according to polymers, which, before entering a pelletising, extrusion or moulding process, have not been subjected to any further processing; plastics flakes that, before their utilisation in an end-product, are not subjected to any further processing."*
- Although the implementing decision refers explicitly to packaging that falls under the PPWD, the new methodology with the calculation point (2) was extended hypothetically to all other applications. The aim is that the report should ensure uniformity of the data and thus comparability between the individual plastic applications and waste flows.

New content as part of the present study

Calculation points for recording recycling volumes in the recycling process at the recovery of collected waste from light-packaging

- The following simplified schematic representation of the process steps illustrates the calculation points for determining the recycling volumes with the help of the process steps for recycling according to the recording and treatment of lightweight packaging.



- Calculation point (1) refers to the input into the recycling plant, irrespective of how many and what internal recycling processing steps are passed through.
- Calculation point (2) as per EU implementing decision, refers only to the last, actual compounding and converting step of the prepared secondary material.

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Summary of the main results

Material flow analysis plastics in Germany 2021: At a glance

Plastics 2021 – A brief overview (1/3)



Total plastics production (plastic materials based on fossil and biobased raw materials, secondary raw materials or by-products and other plastics, e.g. for adhesives, paints, coatings, fibres etc.) amounted in 2021 to approx. 21.1m t.



Plastics production, predominantly based on fossil raw materials, amounted in 2021 to around 18.7m t. The production of relevance for plastic materials was 10.7m t and thus approx. 4.0% above the level of 2019. For the supply of raw materials for the production of plastic products, around 1.65m t of recyclate and approx. 0.64m t of by-products were additionally made available.¹⁾



Plastics converting showed a volume of 14.0m t for 2021, including the use of plastics from fossil raw materials, recyclate and the reuse of by-products. Increases in the converting volumes (compared with 2019) in e.g. the construction sector were offset by declining volumes especially in the automotive sector. Overall, the quantity of plastics used in converting were just under 1.4% below the level of 2019. The use of recyclate from post-consumer and post-industrial waste amounted to around 1.65m t. In addition, use was made of around 0.64m t of by-products.¹⁾



Plastics consumption by end-users rose slightly in the last two years and amounted in 2021 to a total of around 12.4m t. A comparison with the quantities processed in Germany shows an export surplus for plastic products or products with a substantial plastic content (e.g. automotive) totalling around 12%.

1) Further details and explanation regarding the recyclate quantities and by-products for supplying the market, see page 15.

Summary of the main results

Material flow analysis plastics in Germany 2021: At a glance

Plastics 2021 – A brief overview (2/3)



In total, more than 99% of the plastic waste was subjected to material recycling or energy recovery, less than 1% was landfilled.



Around 47% of all plastic waste, or 35% according to the new calculation point (2)¹, was subjected to material recycling (predominantly mechanical). In the field of post-consumer waste, the proportion of material recycling was a good 45% and, according to the new calculation point (2)¹, around 33%. The proportion of chemical recycling was approx. 26 kt, primarily still based on the use of plastic waste as a reducing agent in steel production.



Around 53% of the plastic waste was used for energy generation, or 64% measured according to the new calculation point (2)¹. In the field of post-consumer waste, the proportion of energy recovery was around 66%, measured according to the new calculation point (2)¹.



Plastics recycling and particularly the use of plastic recyclate have become established as an important part of the plastics industry and the supply of raw materials. Of the quantities of plastics waste produced in Germany, around 2.62m t was mechanically recycled in 2021 according to the previous calculation point (1) or 1.96m t according to the new calculation point (2). Through this new calculation procedure, which measures the recycling by the introduction into the last stage of the recycling process (cf. pages 9-10), and no longer at the entrance to the recycling unit¹, the recorded recycling quantity declined nominally very slightly. Effectively, and based on the previous method of calculation (as per calculation point (1)), the recycling volumes rose by approx. 360 kt. The main contributor to this was the increased recycling from post-consumer waste, especially in the field of packaging.

1) See explanation pp 9-10

Summary of the main results

Material flow analysis plastics in Germany 2021: At a glance

Plastics 2021 – A brief overview (3/3)



In total, 1.65m t of **recyclate** (from post-consumer and post-industrial waste) were used for the manufacture of plastic products in Germany.



In addition, around 0.64m t of **by-products from production/processing processes** were reused for the manufacture of plastic products in Germany.



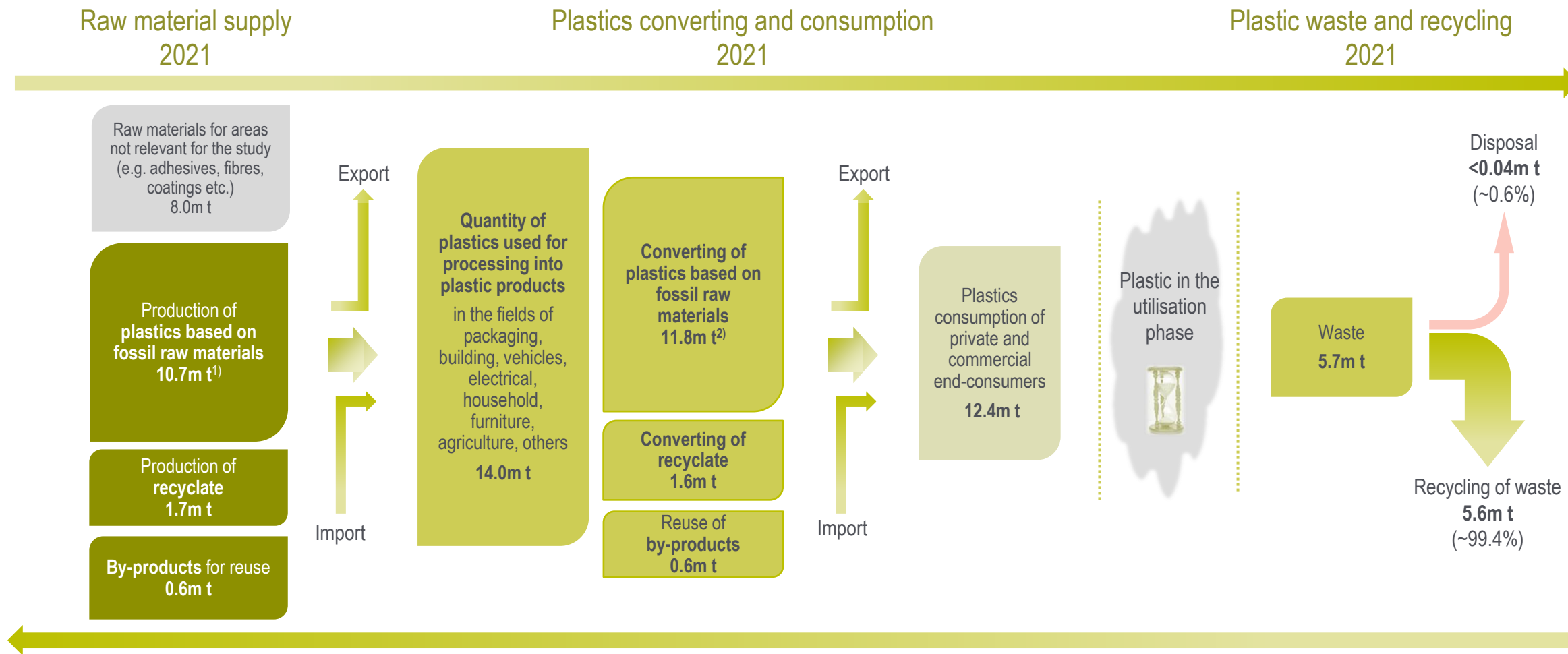
The plastic recyclate obtained from post-industrial and post-consumer waste is used above all in the construction sector as well as the fields of packaging and agriculture.

Overall, the share of utilised plastic recyclate used (from post-consumer and post-industrial wastes) in the total processing quantity in Germany in 2021 was approx. 11.7%.

The proportion of recyclate from post-consumer waste was approx. 9.1%, amounting to 1.3m t.

Summary of the main results

Material flow analysis plastics in Germany 2021: At a glance



1) Plastic types: LD/LLDPE, HD/MDPE, PP, PVC, PS, PS-E, PA, PET, ABS, ASA, SAN, PMMA, other thermoplastics, other plastics incl. PU
2) Included at low proportions, quantities from biobased raw materials

The above quantities are shown as rounded-off figures

Summary of the main results

Comparison of consumption and waste quantities

Comparison of plastics consumption and waste volumes in Germany with the help of 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) amounted to approx. 12.4 m t in 2021. 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 2021, more than 98% 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.

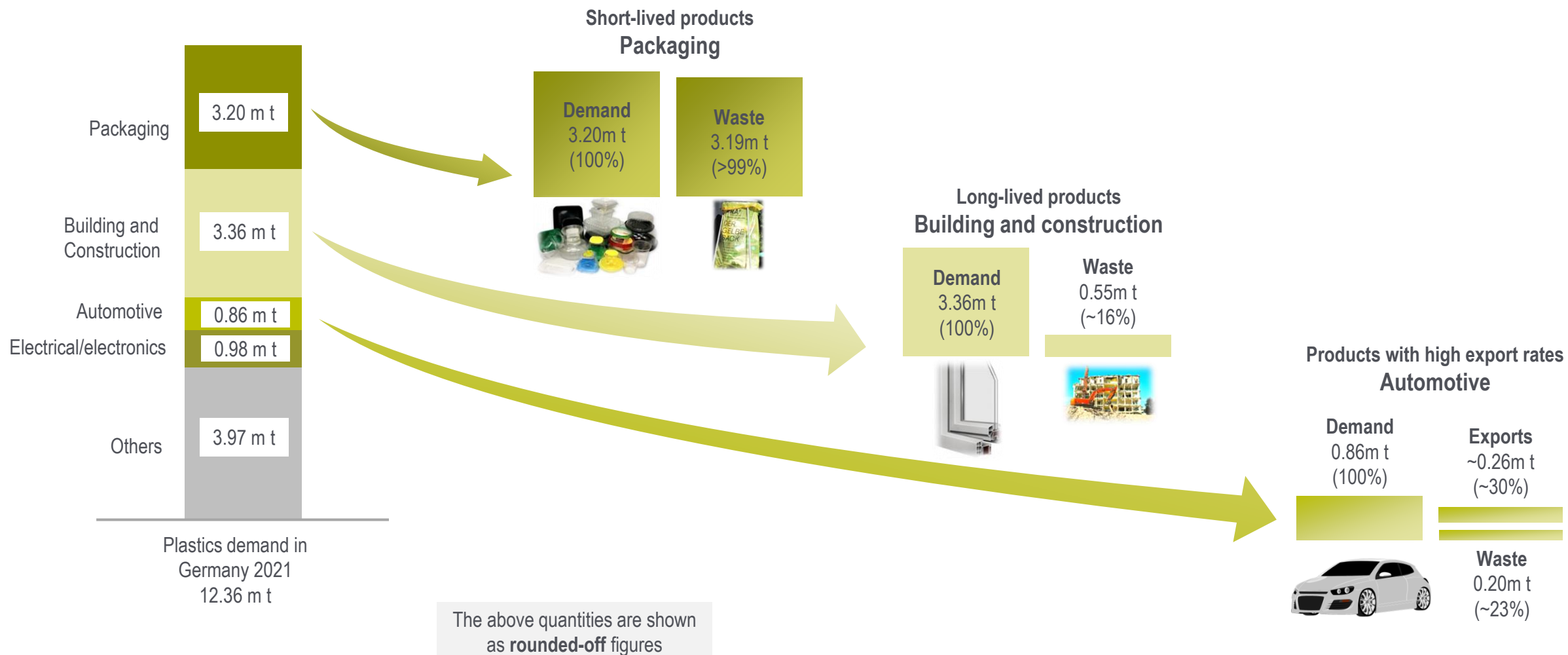
- **Products with a high export share, e.g. automotive**

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, a large proportion 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 only around 560,000 of the approx. 3 million vehicles deleted every year from the German vehicle register end up in German shredder facilities and thus appear in the waste volume in Germany.

Summary of the main results

Comparison of consumption and waste quantities

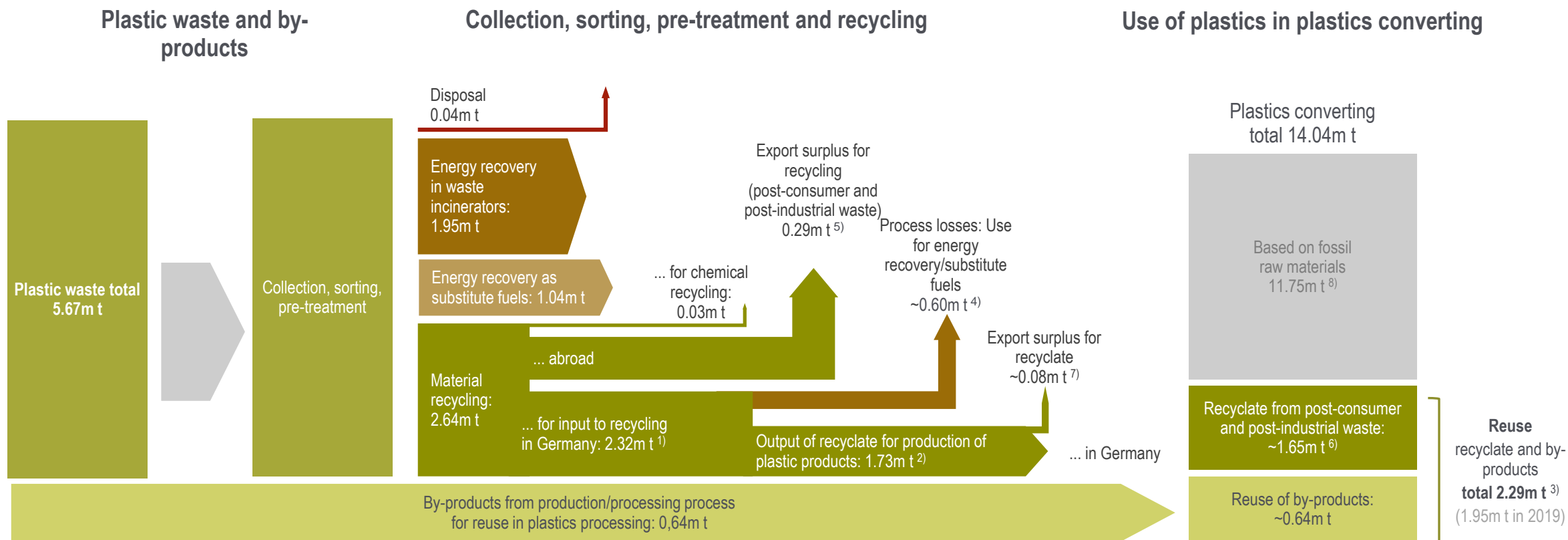
Comparison of plastics consumption and waste volumes in Germany on the basis of key examples (2/2)



Summary of the main results

Treatment of plastic waste and use for plastics converting

Material flow diagram: Treatment of plastic waste for utilisation in plastics converting industry and reuse of by-products



¹⁾ Recycling of post-consumer and post-industrial waste, without by-products

²⁾ Recyclate from the processing of post-consumer and post-industrial waste, without by-products

³⁾ Including approx. 0.2m t of recyclate at recyclers with own product production (frequently for agricultural applications, building applications or other applications, e.g. traffic safety etc.)

⁴⁾ Small quantities of process losses in the recyclate of post-industrial waste were taken into account in the shown quantities for "energy recovery in waste incineration or as substitute fuels"

⁵⁾ Results from the export surplus with post-consumer waste amounting to 0.38m t and an import surplus with post-industrial waste amounting to 0.09m t

⁶⁾ Of which 1.27m t recyclate from the processing of post-consumer waste and 0.38m t from the processing of post-industrial waste

⁷⁾ Results from an export surplus with recyclate from post-consumer waste amounting to 0.19m t and an import surplus with recyclate from post-industrial waste amounting to 0.11m t

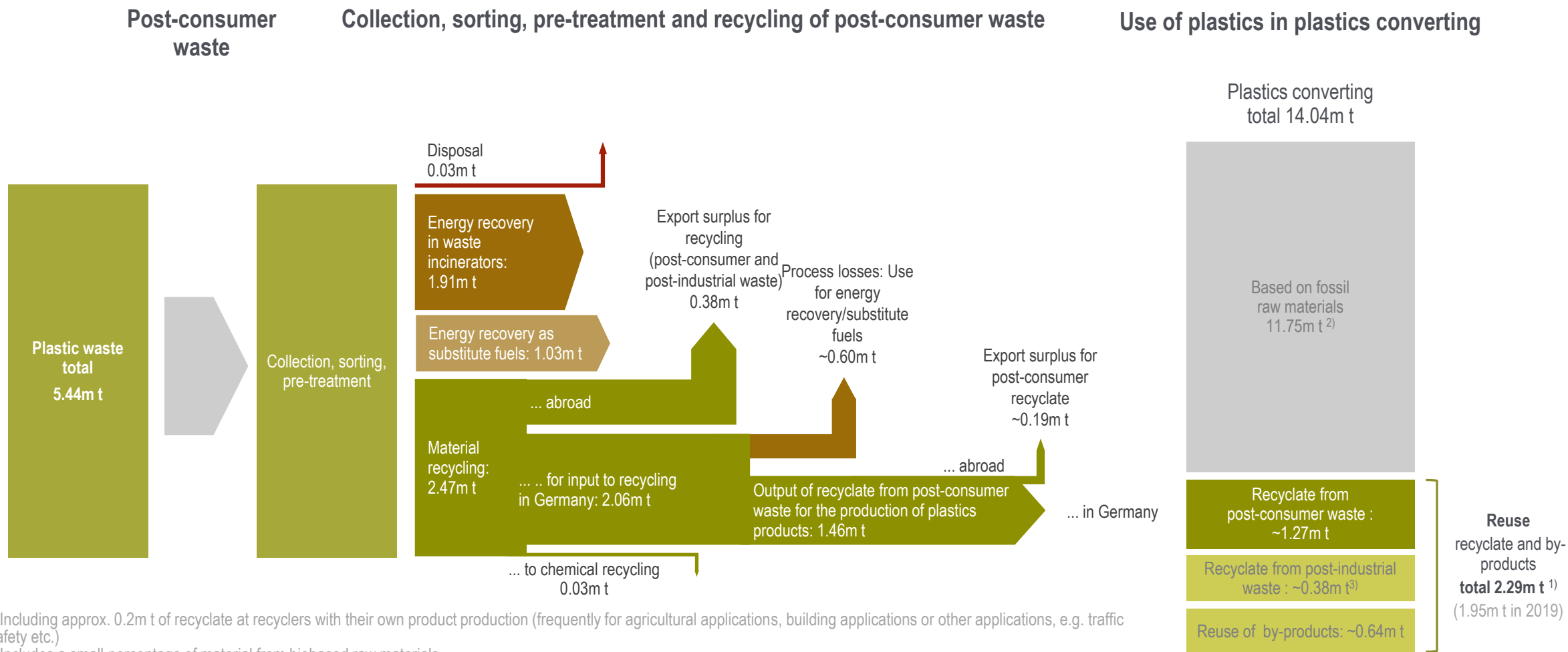
⁸⁾ Includes a small percentage of material from biobased raw materials

(Figures rounded up/down)

Summary of the main results

Treatment of post-consumer waste and use for plastics converting

Material flow diagram: Converting of post-consumer waste for utilisation in plastics converting



¹⁾ Including approx. 0.2m t of recyclate at recyclers with their own product production (frequently for agricultural applications, building applications or other applications, e.g. traffic safety etc.)

²⁾ Includes a small percentage of material from biobased raw materials

³⁾ Includes import surpluses

(Figures rounded up/down)

Summary of the main results

Treatment of plastic waste and reuse of by-products in plastics converting

Summary

- A total of 5.67m t of plastic waste was collected in Germany in 2021 and sent for recycling or energy recovery. Post-consumer waste amounted to around 5.44m t, and post-industrial waste to around 0.24m t.¹⁾
- Apart from that, a quantity of around 0.64m t of by-products (from production/converting processes) was processed and used again for the manufacture of plastic products.
- According to the previous calculation point (1), a total of 2.64m t of all plastic waste (or 2.47m t of post-consumer waste) were sent for material recycling, and according to the new calculation point (2), 1.98m t of plastic waste (of which 1.81m t from the post-consumer segment) - see explanations on pp. 9-10. A total of 2.32m t was sent for material recycling in Germany. Of this, the recycle output (production of recycle from post-consumer and post-industrial waste) in Germany totalled 1.73m t.
- In the field of post-consumer waste, the output of recycle was 1.46m t (production of recycle in Germany; approx. 27% of the waste quantity). Of this, approx. 1.27m t of recycle was used in Germany for the manufacture of new products.
- Related to the volume of plastics processed, the share of recycle (recycle from post-consumer waste and post-industrial waste) was 11.7%. A further 4.6% of the processed quantity of plastics results from the reuse of by-products.
- Of the total of around 2.3m t of recycle and by-products used in plastics converting in Germany, around 1.66m t was used as supplement/substitution of plastics based on fossil raw materials, 0.63m t as a substitute for materials such as concrete, wood and steel, and 0.023m t as a reducing agent in the steel production process.
- In the processing of recycle from post-consumer waste (1.27m t), the share used for the substitution of plastics based on fossil raw materials was approx. 0.64m t, for the substitution of other materials approx. 0.63m t, and for use as a reducing agent in the blast furnace process 0.023m t, and for chemical recycling around 3 kt.

¹⁾ Rounded sum of 52 kt waste from plastics production and 184 kt waste from plastics converting

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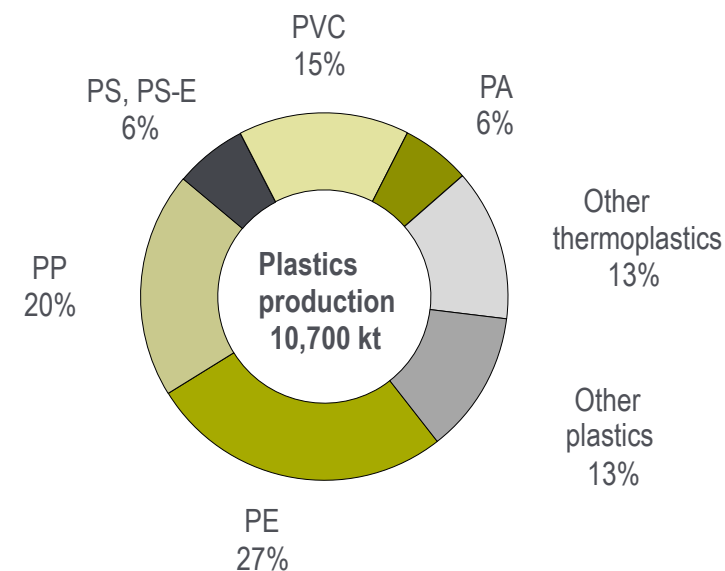
Plastics production

Plastics production (materials based on fossil raw materials) in Germany

Production volumes (based on fossil raw materials) by type of plastic in 2021

Plastics production (based on fossil raw Materials) ¹⁾	Production volume		Change vs. 2019	
	2019	2021	CAGR	Total growth
PE	2,735	2,860	2.3%	4.6%
PP	2,055	2,130	1.8%	3.6%
PS, PS-E	535	680	12.7%	27.1%
PVC	1,595	1,610	0.5%	0.9%
PA	650	650	0.0%	0.0%
Other thermoplastics ²⁾	1,410	1,430	0.7%	1.4%
Other plastics ³⁾	1,305	1,340	1.3%	2.7%
Total	10,285	10,700	2.0%	4.0%

Share of the production volume 2021



- In 2021, plastics production (based on fossil raw materials) in Germany totalled approx. 10.7m t. The production volume thus exceeded the level of 2019 by 4.0%.
- The volume increased, for example, with the polyolefins (PE and PP) and with PS, PS-E⁴⁾ and PVC.
- There were no significant changes in the production of PA – also caused by restructuring at individual producers. In the coming years, however, it can be assumed that the production volumes will rise.

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

²⁾ e.g. PET, ABS, ASA, SAN, PMMA, PC, POM etc.

³⁾ e.g. PU

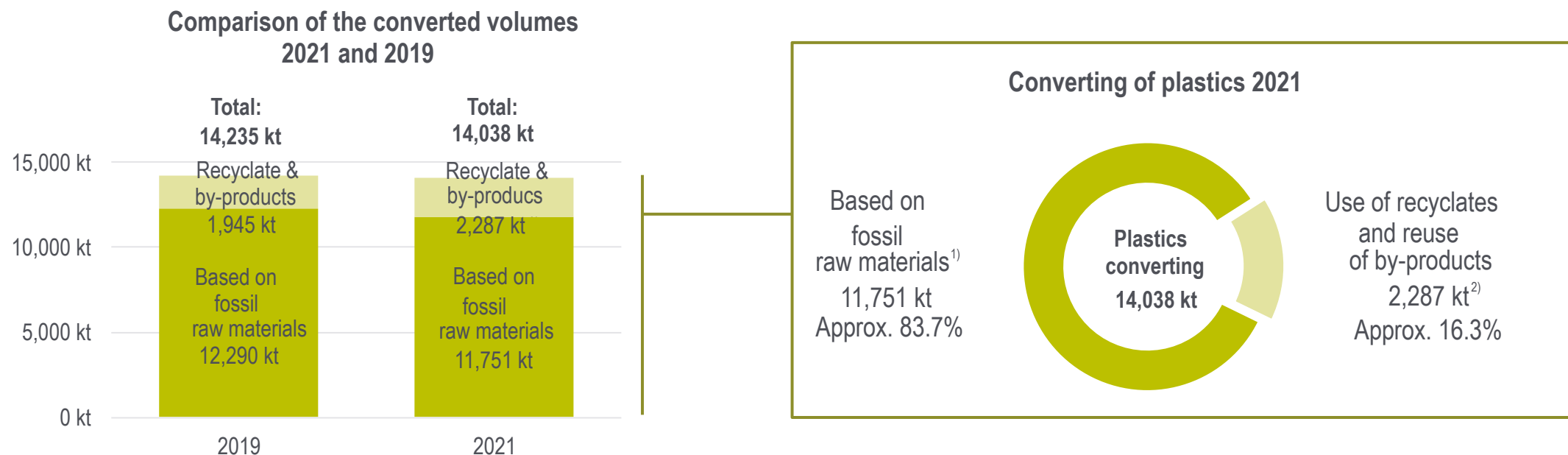
⁴⁾ Including individual newly recorded capacities for the production of PS-E in 2021

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Plastics converting

Overview: Converting of plastic materials 2021/2019

Converting of plastics based on fossil raw materials, recyclate and reuse of by-products: Overview 2021/2019



- The total processed volume for the year 2021 was 14,038 kt.
- The volume was thus around 1.4% below that of 2019. Although the converting volumes increased compared with the previous year 2020 by around 4-5%, the decline of 5-6% in 2020 (compared with 2019) was thus not fully compensated..
- Based on the recorded amount of recyclate and the reuse of by-products of 2,287 kt, this resulted in 2021 in a share of 16.3% of the total processed volume. The proportion of plastics based on fossil raw materials in 2021 was 83.7% (86.3% in 2019), falling by 539 kt. This represents a decrease of 4.4%.

¹⁾ Contains small proportions of bio-based raw materials ²⁾ Results from the use of recyclate amounting to 1,648 kt (of which 376 kt from the recycling of post-industrial waste and 1,272 kt from the recycling of post-consumer waste) and the reuse of by-products amounting to 639 kt ³⁾ A differentiation of recyclate and by-products was not made in the 2019 survey. For the sake of comparability, the total quantity of recyclate and by-products is shown here together.

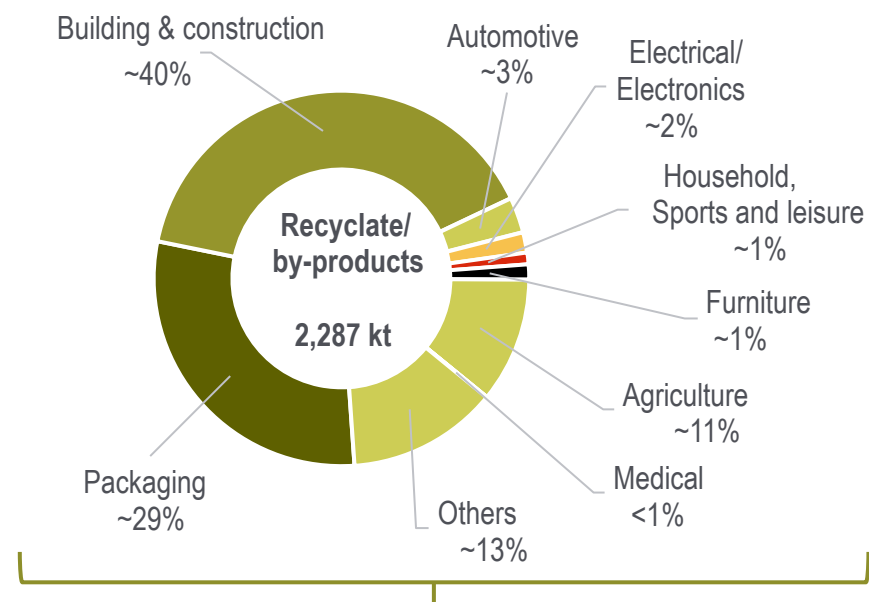
Plastics converting

Overview: Converting by industry and by type of plastic material used

Volume of plastic materials processed by relevant industries 2021

Plastics converting 2021	Total (kt)	... of which			
		Based on fossil raw materials (kt)	Recyclate/by-products (kt)	Based on fossil raw materials (%)	Recyclate/by-products (%)
Packaging	4,378	3,708	670	84.7%	15.3%
Building and construction	3,690	2,780	910	75.3%	24.7%
Automotive	1,230	1,160	70	94.3%	5.7%
Electrical/Electronics	895	855	40	95.5%	4.5%
Household, Sports and leisure	465	442	23	95.1%	4.9%
Furniture	435	405	30	93.1%	6.9%
Agriculture	595	348	247	58.5%	41.5%
Medical	280	280	0	99.9%	0.1%
Others	2,070	1,773	297	85.7%	14.3%
Total	14,038	11,751	2,287	83.7%	16.3%

Use of recyclates and reuse of by-products by sector 2021



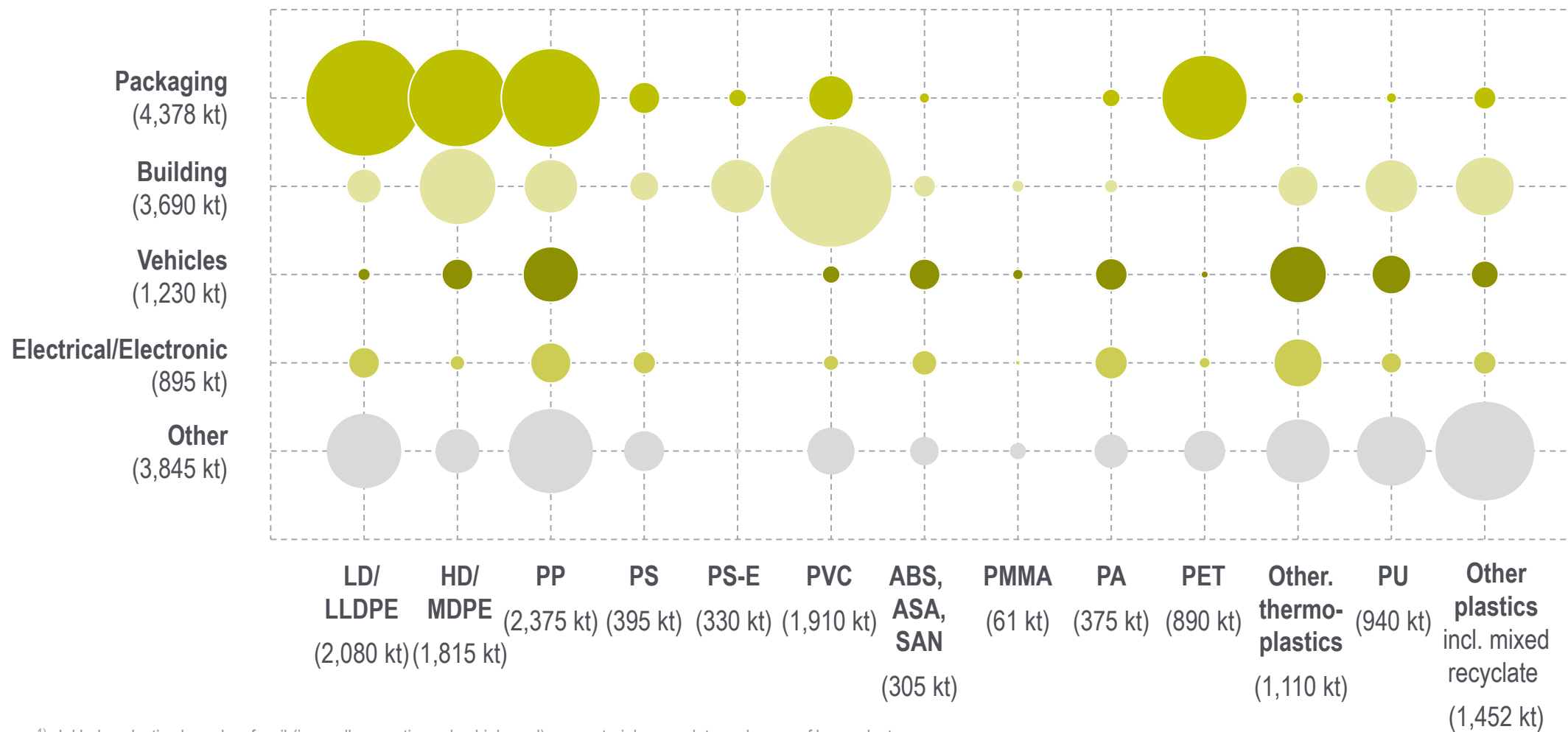
- The different application areas show different degrees of use of plastics based on fossil raw materials or recyclate and the reuse of by-products.
- Significant amounts of recyclate and the reuse of by-products are found in construction, packaging and agricultural applications (24.7% in construction, 15.3% in packaging and 41.5% in agriculture).

¹⁾ Includes a small percentage of material from biobased raw materials

Plastics converting

Types of plastic and industries

Structure of the converted plastics demanded from industry sectors: Overview¹⁾



¹⁾ Inkludes plastics based on fossil (in small proportions also biobased) raw materials, recyclate and reuse of by-products


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Plastic waste and recycling

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

Post-consumer waste by main fields of application

Sector	Comparison share of plastics consumption vs waste generation		Post-consumer waste in kt		Change vs. 2019	
	Plastics consumption	Waste generation	2019	2021	nominal	CAGR
Packaging	25.9%	58.7%	3,160	3,195	1.1%	0.6%
Building & construction	27.2%	10.1%	522	550	5.4%	2.7%
Automotive	6.9%	3.7%	233	200	-14.4%	-7.5%
Electrical / Electronics	7.9%	6.1%	316	329	4.1%	2.0%
Household, sports, leisure	5.3%	3.2%	169	175	3.5%	1.8%
Agriculture	5.3%	6.2%	295	338	14.8%	7.1%
Others	21.6%	12.0%	655	652	-0.5%	-0.3%
Total	100%	100%	5,350	5,439	1.7%	0.8%

	Quotas acc. to calculation point (1) ³⁾ 2021 (2019)	Quotas acc. to calculation point (2) ³⁾ 2021
<ul style="list-style-type: none"> ▪ Recyclate rate – Mechanical – Feedstock 	45% (39%) 45% (38%) <1% (<1%)	33% 33% <1%
<ul style="list-style-type: none"> ▪ Reuse rate – Energy 	99% (99%) 54% (61%)	99% 66%
<ul style="list-style-type: none"> ▪ Disposal – Landfill 	1% (1%) 1% (1%)	1% 1%

- Although the total quantity of post-consumer waste increased slightly in 2021, the post-consumer waste volumes were not higher in all applications. Reductions were registered in particular in the application "vehicles".
- The total amount of plastic packaging waste increased by 1.1% compared with 2019. In the field of agriculture, the volume of plastic building products (e.g. film/sheet, plastic products from private end-consumers) increased further.

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

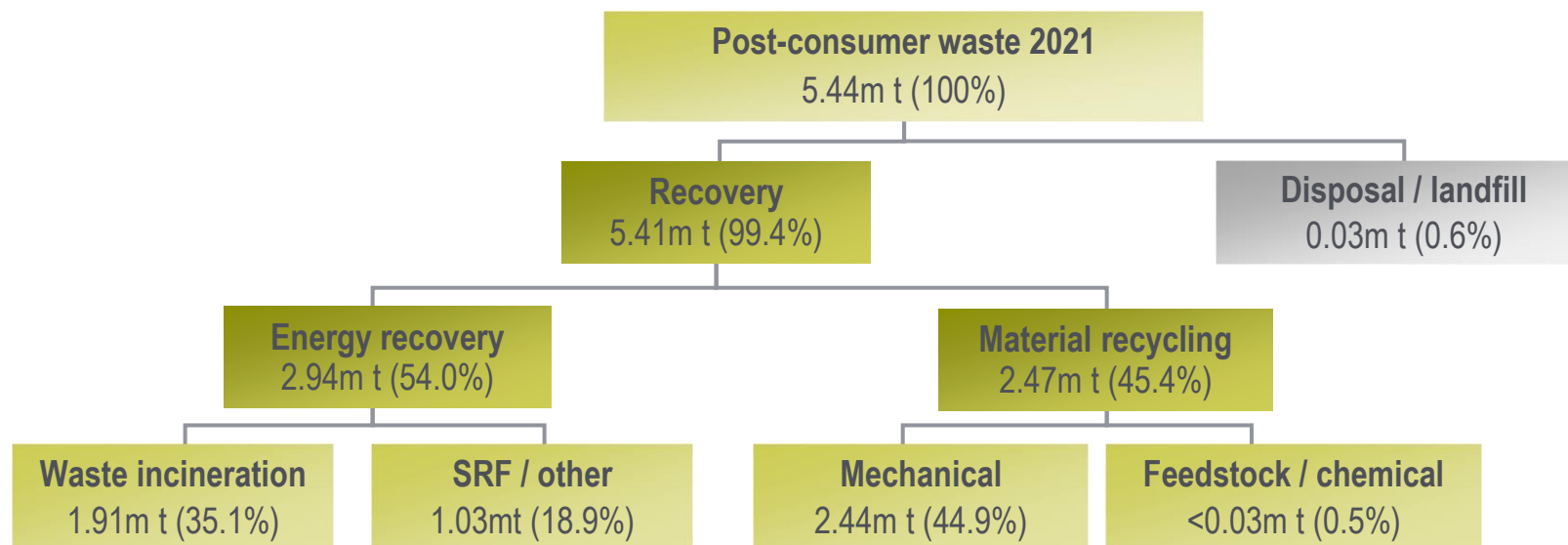
²⁾ Figures in the table are rounded up/down

³⁾ See pp. 9-10

The above quantities are shown as **rounded** figures.

Plastic waste and recycling

Recycling of post-consumer waste according to previous calculation point (1)



Around 99.4% of all post-consumer plastic waste generated in Germany in 2021 underwent material recycling or was used for energy recovery (i.e. also taking account of energy-efficient waste incinerators).

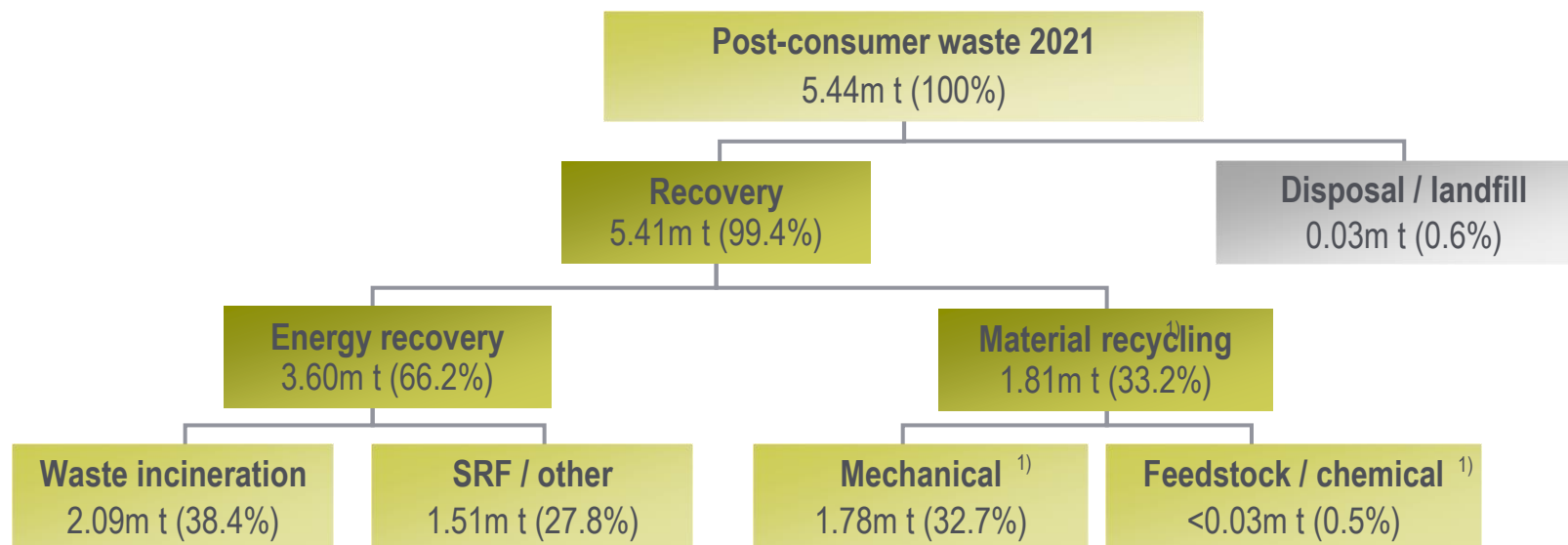
A look at the recovery targets according to the previous calculation point (1) shows that approx. 45% is recycled mechanically, <1% by chemical recycling and 54% through energy recovery. Around 0.6% of the waste is still being landfilled. Germany thus attains the highest material recycling targets in Europe.

Around 19% of all post-consumer waste is used as a solid recovered fuel (SRF) in special power plants in commerce and industry and also in co-combustion (e.g. cement kilns). The proportion of energy recovery via municipal solid waste incineration (MSWI) is approx. 35%.

The above quantities are shown as **rounded** figures.

Plastic waste and recycling

Recycling of post-consumer waste according to previous calculation point (2)



1) See explanation pp. 9-10

Around 99.4% of all post-consumer plastic waste generated in Germany in 2021 underwent material recycling or was used for energy recovery (i.e. also taking account of energy-efficient waste incinerators).

Calculated on 5.44m t of post-consumer plastic waste, approx. 33% is recycled mechanically¹⁾, <1% by chemical recycling and 66% through energy recovery. Around 0.6% of the waste is still being landfilled. Germany thus attains the highest material recycling targets in Europe.

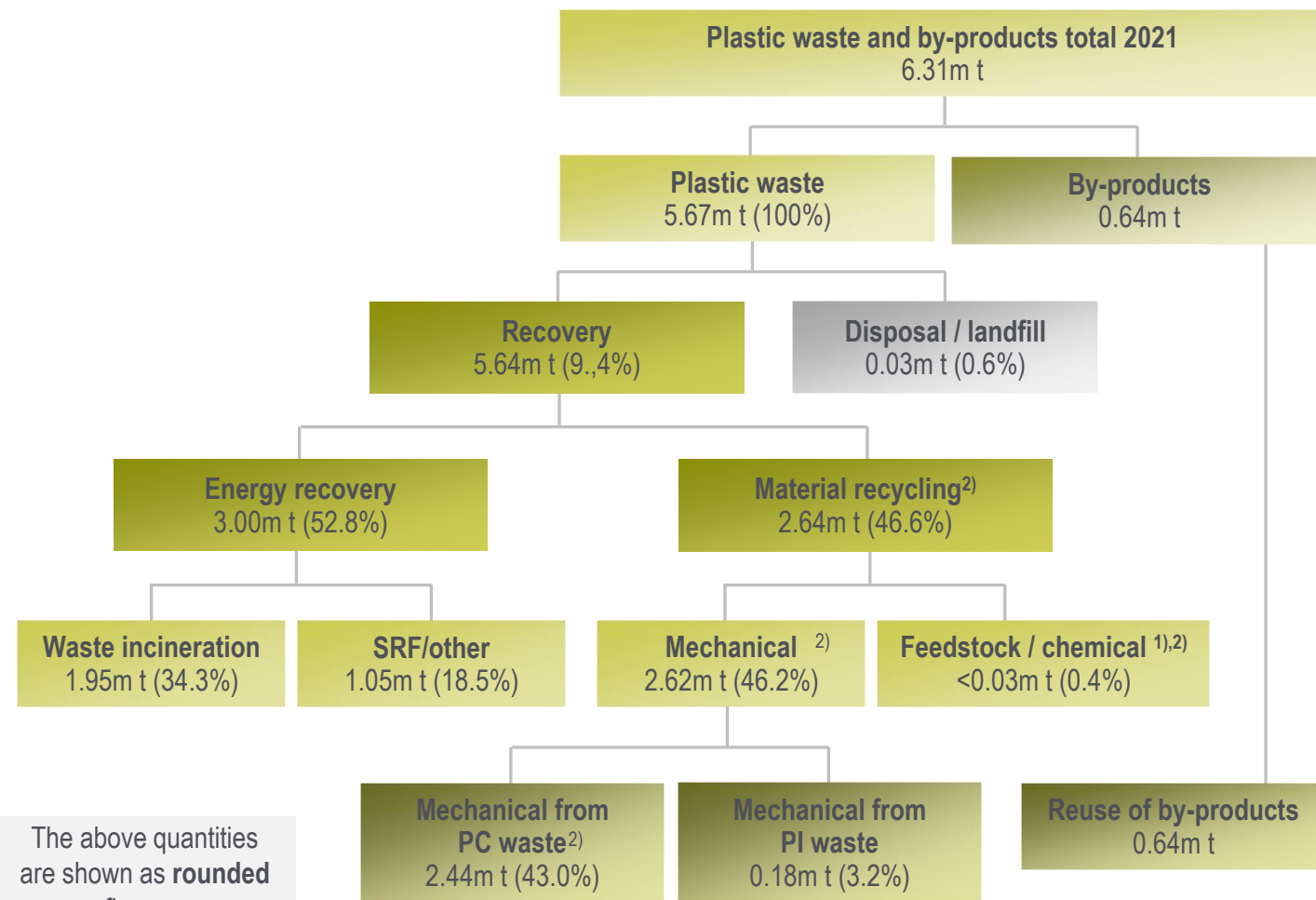
Around 28% of all post-consumer waste is used as a solid recovered fuel (SRF) in special power stations in commerce and industry and also in co-combustion (e.g. cement kilns). The proportion of energy recovery via municipal solid waste incineration (MSWI) is approx. 38%.

The above quantities are shown as **rounded** figures.

Plastic waste and recycling, by-products and reuse

Recycling of plastic waste and reuse of by-products according to previous calculation point (1)

Recycling of plastic waste (incl. post-consumer and post-industrial waste) and reuse of by-products



The above quantities are shown as **rounded** figures.

The recycling quantities for 2021 – measured according to the previous calculation point (1)²⁾ – amount to around 2.64m t (mechanical and chemical recycling).

Of the 5.67m t of plastic waste determined in 2021, 2.62m t underwent mechanical recycling, <0.03m t went for chemical recycling and approx. 3.00m t was sent for energy recovery. Approx. 0.03m t was landfilled.

Furthermore, a quantity of 0.64m t of by-products from the production/conversion process was reused for the production of plastic products.

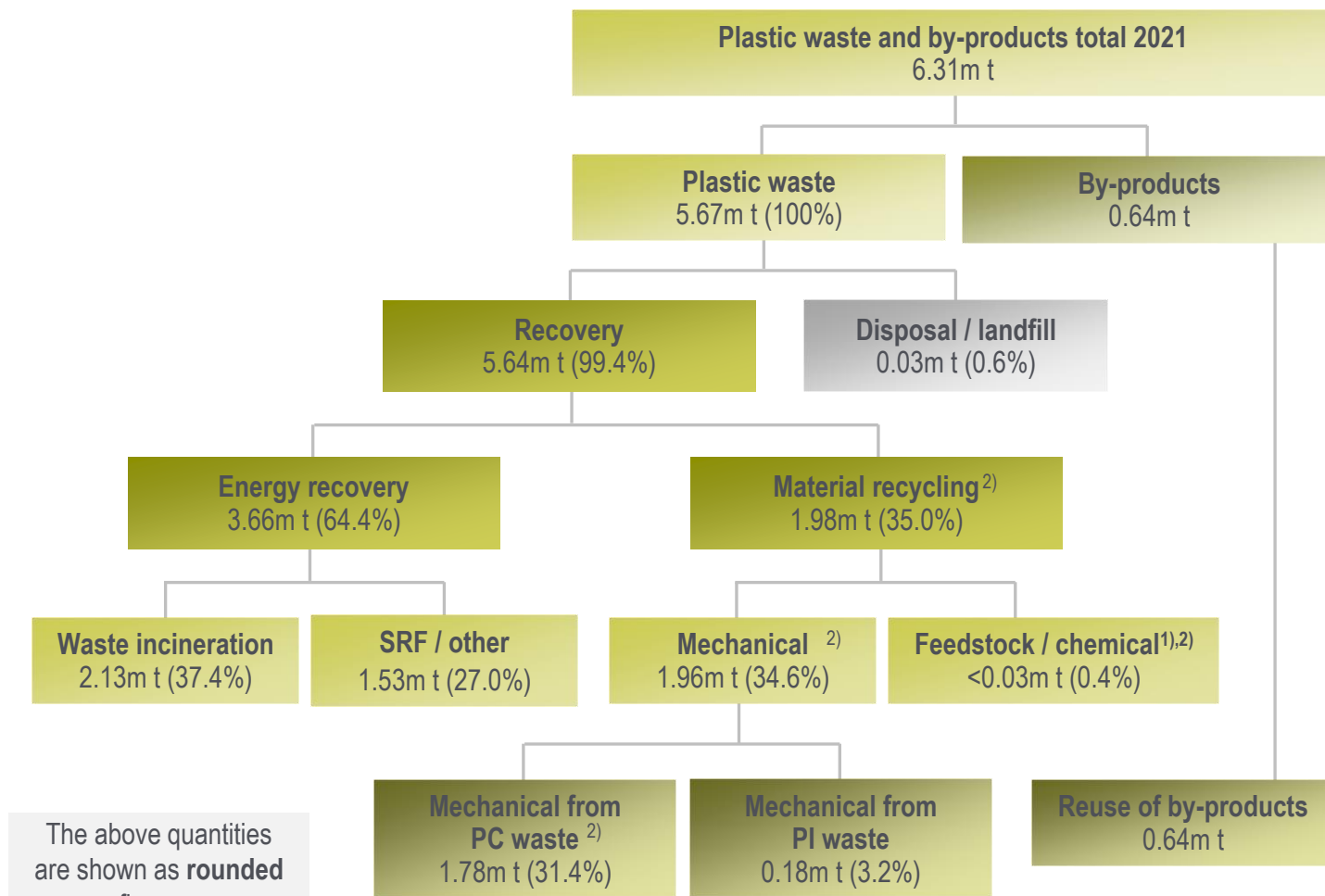
¹⁾ Total quantity contains 23 kt which is used as a reducing agent for recycling in blast furnace and ~3 kt for chemical recycling to produce plastic raw materials.

²⁾ See pp. 9-10

Plastic waste and recycling, by-products and reuse

Recycling of plastic waste and reuse of by-products according to previous calculation point (2)

Recycling of plastic waste (incl. post-consumer and post-industrial waste) and reuse of by-products



The above quantities are shown as rounded figures.

Of the 5.67m t of plastic waste determined in 2021, 1.96m t underwent mechanical recycling²⁾, <0.03m t went for chemical recycling and approx. 3.00m t was sent for energy recovery. Approx. 0.03m t was landfilled.

The use of plastic waste as a solid recovered fuel (SRF) still plays an important role (approx. 27% calculated on the total quantity of plastic waste). Furthermore, 0.64m t of by-products from the production/conversion process was utilised for the production of plastic products.

The recycling quantities refer to the plastic waste generated in Germany – measured according to calculation point (2)²⁾ – irrespective of whether it was recycled in Germany or in other countries. The recycling quantities thus do not represent the recycling quantities that are processed at German recyclers.

¹⁾ Total quantity contains 23 kt which is used as a reducing agent for recycling in blast furnace and ~3 kt for chemical recycling to produce plastic raw materials.

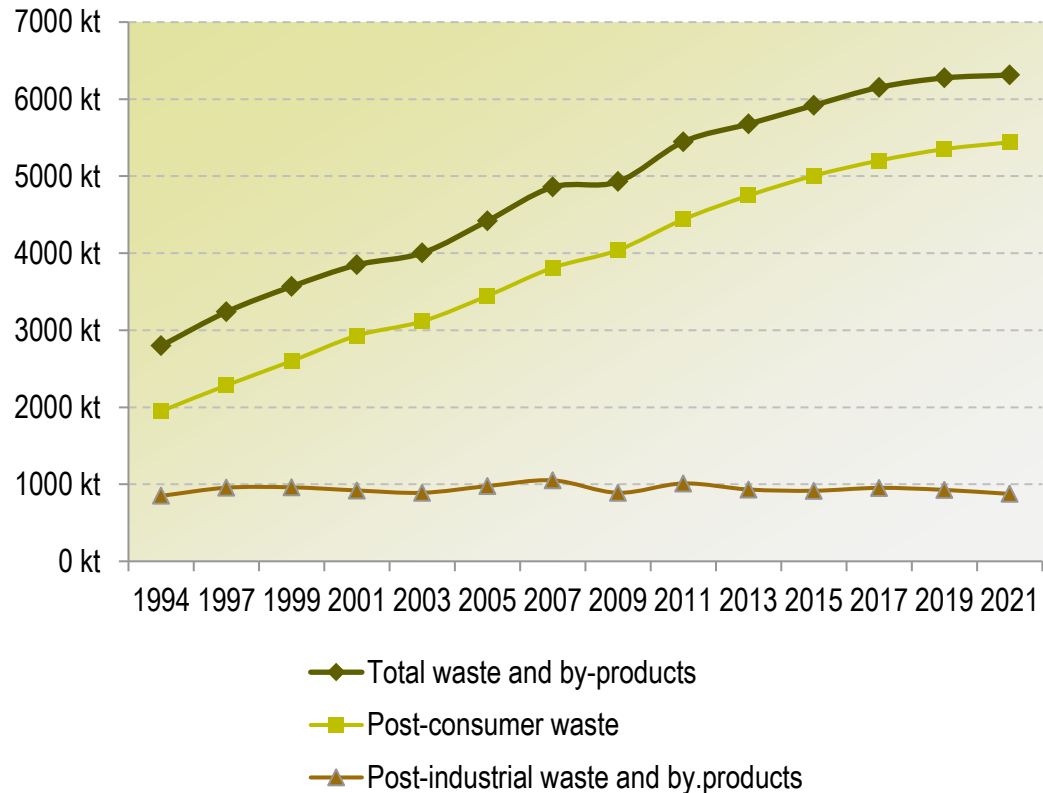
²⁾ See pp. 9-10

Plastic waste and recycling, by-products and reuse

Development of the plastic waste and by-products in a time series

Quantities of plastic waste and by-products in a time series from 1994 - 2021

Quantities of plastic waste and by-products¹⁾



- The total volume of plastic waste and by-products increased in the period from 1994 to 2021 from 2.80 to approx. 6.31m t. This represents a rise of approx. 3.1% p.a. or around 3.51m t in the given period.
- This increase is almost exclusively attributable to the rise in the post-consumer segment. Here, the amount of waste rose from 1.95m t in 1994 and around 5.44m t in 2021. This represents an increase of approx. 3.9% p.a. The increase is thus now above the increase in consumption in percentage terms, which is due to the increased rate of return of medium-life and long-life plastic products.
- The quantities of waste from the post-industrial segment and by-products rose only slightly because of improved production and converting processes (1994: 850 kt / 2021: 875 kt).¹⁾ Compared with 2019, the quantities of waste from the post-industrial segment and by-products fell by 52 kt.

¹⁾ For the collection of data in 2021, a new differentiation between waste and by-products was introduced. This should be taken into account both for the overall curve and for the production and converting processes, see pp. 7-8

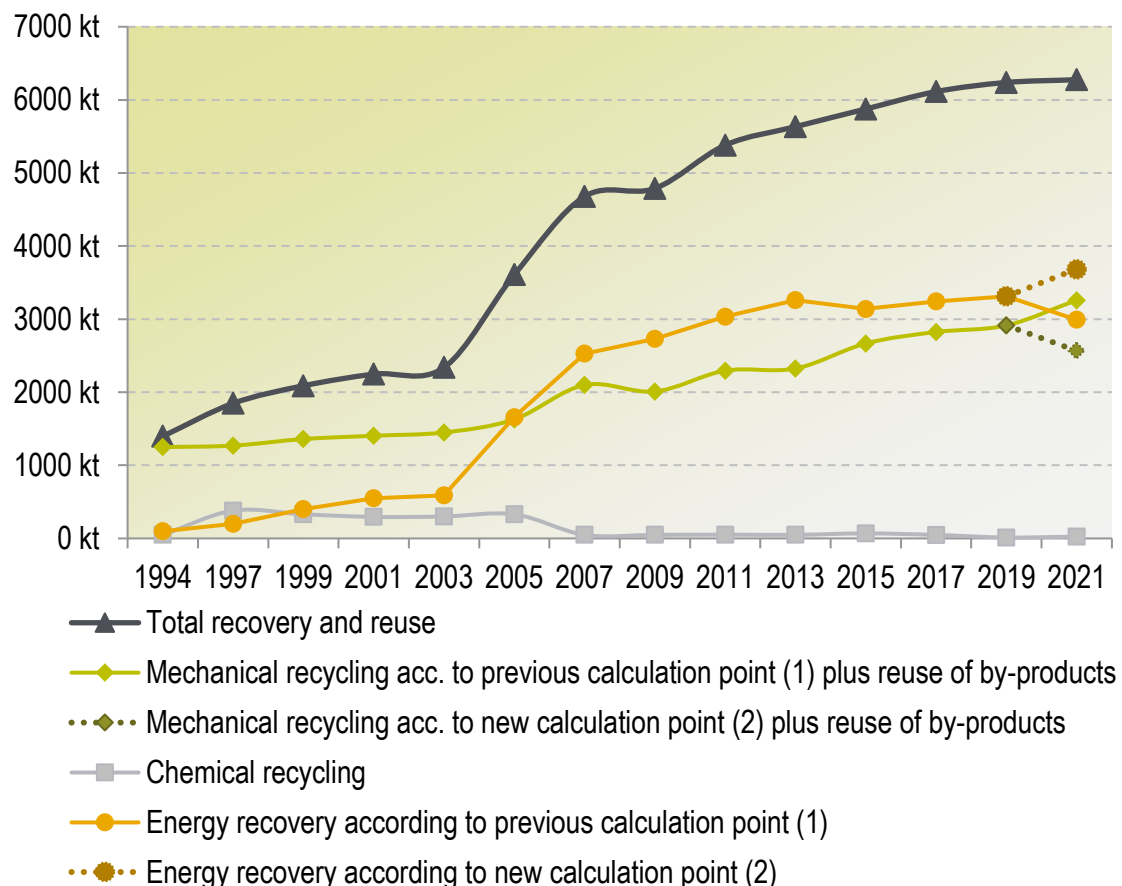
²⁾ Constant waste generation from production and converting despite increasing production and converting quantities in the period from 1994 - 2021 because of significant efficiency increases.

Plastic waste and recycling, by-products and reuse

Development of the plastic waste and by-products in a time series

Development of recycling and reuse in a time series from 1994 - 2021

Mechanical and chemical recycling and energy recovery of the documented plastic waste, plus reuse of by-products¹⁾



- The total amount of mechanical recycling²⁾ plus the use of by-products amounted in 2021 to around 3.26m t. This represents an increase of approx. 2.01m t compared with the figure for 1994. The average increase from 1994 to 2021 was approx. 3.6% annually. After somewhat more subdued development in the years from 2009-2013, recycling has gained dynamism in the last few years.
- Chemical recycling³⁾, which rose considerably at the beginning of the decade and then became stuck at a level of approx. 300 kt, amounted in 2021 to around 26 kt and was thus below the level of the previous years (mostly 50-70 kt in the years from 2007-2019).
- The quantities for energy recovery in 2021 declined by approx. 320 kt according to previous calculation point (1)²⁾. The volume share for use as a SRF in 2021 was just under 23% (of total plastic waste) or 20% (of post-consumer waste)..

¹⁾ For the collection of data in 2021, a new differentiation between waste and by-products was introduced. This should be taken into account both for the overall curve and for the production and converting processes, see pp. 7-8.

²⁾ In detail, with the mechanical recycling, a distinction is made as regards the method between previous and new calculation point, see pp. 9-10.

³⁾ Total sum contains 23 kt, which is used as a reducing agent for chemical recycling and ~3 kt chemical recycling for producing plastic raw materials.

Annexe

Annexe

Glossary (1/8)

Plastics production, converting and consumption

<p>Plastics production</p>	<p>The focus here is on plastics for the production of plastics products by polymerisation, which are demanded by the converting industry in the form of moulding 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 converting are not included in this part of the study. They are covered in the section of the study on “Plastics converting“. This part of the study focuses on production volumes at sites in Germany.</p>
<p>Plastics converting</p>	<p>The converting or conversion of plastics into products, based on fossil/biobased raw materials, recycle and the reuse of by-products. The focus is on volumes processed 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 converting. In the field of packaging, only imports and exports of non-filled packaging were taken into account.</p>

Annexe

Glossary (2/8)

Plastics based on fossil raw materials, plastics recyclate

<p>Plastics based on fossil raw materials</p>	<p>Plastics based on fossil raw materials is the term used to describe moulding compounds (e.g. powder, granules, starting materials, e.g. PU raw materials) produced by polymerisation that are demanded by the converting industry. Raw materials obtained from the recycling of post-industrial or post-consumer waste are not included here (see "plastics recyclate").</p>
<p>Plastics recyclate</p>	<p>Plastics recyclate is obtained from the recycling of post-industrial or post-consumer waste. The converting to recyclate takes place in the form of regrind, ground material, regenerate or compounds, agglomerates or compactates. The produced recyclate is again used in the converting to plastic products.</p>

Annexe

Glossary (3/8)

Where plastic waste is generated

Plastics producers	In the study, plastics producers are taken to mean only raw material producers who sell the products they produce by polymerisation to the further converting industry in the form of moulding compounds (e.g. powder, granules, starting materials, e.g. PU raw materials). The resins that are 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 converters	Plastics converters are companies that, either as their main activity or within a production area, process plastics based on fossil/biobased raw materials, recycle or by-products 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 any commercial activities.

Annexe

Glossary (4/8)

Waste, by-products

Post-industrial waste	Post-industrial waste is the term used for plastics that arise during the production or processing of plastics and leave the plant or process for treatment. As a rule, the materials are produced in a single type (sorted) and the user is basically familiar with their content. Post-industrial waste is documented under a code number according to waste catalogue. Materials that are utilised 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, floorings, canvas etc. The waste is frequently soiled and/or mixed.
By-products	According to §4 of the Kreislaufwirtschaftsgesetz (German Waste Management Act), a by-product is a material or object that results from a production process, the main purpose of which is not to produce this material or object, and if <ol style="list-style-type: none"> 1. it is ensured that the material or object will be used further, 2. an additional pre-treatment, over and above a normal industrial process, is not necessary for this, 3. the material or object is produced as an integral part of a production process, and 4. its further use is legal; this is the case when the material or object complies with all the product, environmental and health protection requirements that apply to its respective use, and overall does not have any harmful effect on man or the environment. By-products are not recorded under a code number according to waste catalogue.

Annexe

Glossary (5/8)

Disposal, recycling, elimination, material, mechanical and chemical recycling

Waste management	Waste management covers the recovery and disposal of waste.
Recovery	Recovery covers both material recycling and energy recovery. The recovered volumes refer to plastic waste generated 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 recycling companies.
Disposal	Landfilling according to defined criteria or incineration without adequate energy output.
Recycling (material recycling)	Material recycling is subdivided into mechanical recycling and chemical 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.
Chemical 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 depolymerisation, but without energy recovery and incineration. Chemical recycling is synonymously used with feedstock recycling.

Annexe

Glossary (6/8)

Energy recovery and RDF/SRF

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 kiln plants. With energy recovery, the technical definition is taken as the basis: incineration in a waste incinerator with effective energy output or with energy utilisation.
RDF/SRF	Refuse Derived Fuels (RDF) and Solid Recovered Fuels (SRF) 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-combustion plants. For example, the secondary fuels 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 tyres, 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.

Annexe

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	Polyvinylchloride
ABS, ASA, SAN	Acrylonitrile butadiene styrene, acrylonitrile styrene acrylate, styrene acrylonitrile copolymer
PMMA	Polymethyl methacrylate
PA	Polyamide
PET	Polyethylene terephthalate
Other thermoplastics	Other thermoplastics, e.g. POM (polyoxymethylene), PC (polycarbonate), PBT (polybutylene terephthalate), blends etc.
PU	Polyurethane
Other plastics	Other plastics, e.g. thermosetting plastics such as epoxy, phenol and polyester resins, melamine resins, urea resins








Annexe

Glossary (8/8)

Other

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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Annexe Images

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