

Perspectives on the Use of Recyclates as an Important Element in a Sustainable Circular Economy with Plastics

This paper on hand aims at contributing to a fact-based and practice-oriented discussion on the circular economy with plastics and the use of the resulting recyclates from recycling processes as well as presenting suggestions for an increased and reasonable use of recyclates considering both ecological and economic terms. This document relates to the facts and figures, mechanisms and preconditions for using plastics as well as recyclates in any sector application and explicitly in Germany.

At the Core

- A sustainable Circular Economy is key to climate protection. It requires a **holistic lifecycle approach**. In this regards, **resource efficiency** has to be increased at all steps of the value chain.
- Closing the carbon cycle requires a consistent and **effective recovery of materials**:
 - End-user products designed for sustainability towards better recyclability
 - Appropriate waste collection and efficient modern treatment
 - Technology-neutral recycling processes
- Hence, the **utilisation of plastics waste** to, finally, produce recyclates is core for realizing a Circular Economy with plastics. This comes with an **increase of recycled content** in new products, meeting all three main criteria: **quality, availability, and competitive prices**.
- **Carefully set specific legislative targets** of recycled content are supported for use in defined product applications. Undifferentiated and unspecific content targets for the use of recycled material can generally not provide a solution as quality and availability of materials need to be considered.
- Most effective is a well-thought-through **variety of** measures i.e. certain product targets according to existing legislation, voluntary self-commitments, research and development, standardisation & certification, etc.
- Rather than national targets for recycled content, a **European harmonised approach** should be aimed at from the outset.
- Ultimately, the above-mentioned conditions – availability of secondary materials and the fulfilment of the recycle's quality – have to be guaranteed. This is in order to make sure that the **engineers and designers** can use **qualified recyclates** that comply with the requirements of the producer of the final end-products in a future Circular Economy market.

Sustainability is the guiding theme of action for the plastics manufacturing industry. In order to make an important contribution to a sustainable development and climate action, the plastics manufacturers are working intensively towards finding solutions. With their material, the plastics producers play an important role here, especially with regards to the benefit potential of plastics during product use for climate protection such as in light-weight mobility, building insulation etc. up to the efficient recovery of end-user products at the end of their useful life. For a sustainable circular economy, a holistic lifecycle approach is therefore needed.

The path towards greenhouse gas neutrality requires a circular economy. The core of this concept is formed by all contributions to an efficient use of resources in order to reduce the emission of greenhouse gases as well as to ensure the sustainable use of plastic material. This can be successfully done by increasing the resource efficiency at all steps of the value chain, raising the service life of products, and by using renewable energies.

Another key contribution on the way towards a circular economy is the consistent recovery and reuse of materials, especially the strict closing of the carbon cycle. Plastics recyclates are an essential element for the carbon cycle. The pan-European association PlasticsEurope has joined the stakeholder platform “Circular Plastics Alliance” established by the EU Commission in 2019. The central objective of this alliance is to increase the use of recyclates in the EU up to 10 million tonnes per year, by the year 2025. Against this background, PlasticsEurope formulated a voluntary commitment in 2018¹. In this context, European product platforms of individual polymers, such as for PET, polyolefins, polystyrenes, and PVC have been established.

Circular economy with plastics

The plastics manufacturers support measures that enable an intensified use of recycled plastics in products. We are committed to this important element for a more circular economy. Not alone a recyclability of an end-user product, appropriate waste collection and efficient modern treatment as well as recycling technologies but also the re-utilisation of plastic waste to produce recyclates are key to achieve a real circular economy.

This concept is reflected by the “Roadmap 2050” recently presented by the German chemicals industry². It aims to a climate-neutral production by the year 2050. The plastics manufacturers constitute also part of this forward-looking objective within the framework of the circular economy. For the roadmap, DECHEMA and FutureCamp forecasted in their study the underlying technology development scenarios for a circular economy with plastics ranging to the year 2050³.

To realise a circular economy, contributions by all stakeholders of the value chain are necessary: producers, converters, brand owners and OEMs who place final end-products on the market, consumers, the waste management industry, as well as the administration including execution authorities. We therefore support the dialogue with the partners of the value chains, as well as with politicians and authorities, in order to achieve as effectively as possible an interlocking of the parties involved and, hence, of the contributions to the circular economy. Successful examples of this stakeholder co-operation are demonstrated in the web special of PlasticsEurope⁴.

Our understanding within this value chain looks as follows: the plastics industry is the essential supplier of the market with plastics materials, regardless of the raw material basis, be it plastics on the basis of primary, secondary, renewable, or also alternative⁵ materials. Here, we regard the use of recycled materials as an essential element of the circular management of carbon, which we are striving for together with the partners of the value chain.

¹ Plastics 2030, Voluntary Commitment, PlasticsEurope, Brussels (2018)

² www.vci.de/themen/energie-klima/chemistry4climate/chemistry4climate.jsp

³ Roadmap Chemie 2050 – Auf dem Weg zu einer treibhausgasneutralen Chemie in Deutschland (Towards a greenhouse gas-neutral chemical industry in Germany), DECHEMA/FutureCamp Climate, Frankfurt/ Munich (2019)

⁴ www.plasticseurope.org/de/focus-areas/circular-economy/special-kreislaufwirtschaft

⁵ As part of the “Driving innovation and investment towards circular solutions”, the “European Strategy for Plastics in a Circular Economy” published by the EU Commission in 2018 states so-called alternative feedstock (e.g., plastics produced from carbon dioxide or methane), aiming at minimising the use of fossil resources.

Challenge: recycled materials must be available with the requested quality and quantity, and at competitive prices

Recycled plastics must be made available with the quality requested by the market, at competitive prices and in sufficient quantities. These three significant conditions are necessary for recycled materials to be used lastingly and sustainably in products.

The fundament to achieve this is the principle of producer responsibility as set in waste-legislative rules. We support the concept of the privately organised producer responsibility⁶ in principle. Moreover, the plastics manufacturers contribute to this important concept with own activities:

- 1) **Fact basis** through studies and projects, especially the data survey “*Stoffstrombild Kunststoffe in Deutschland 2019*” (plastics flow in Germany 2019) funded by 15 organisations and associations⁷.
- 2) The plastic producers co-operate closely with the partners from the plastics industry. In the **competence platform** of the German plastics industry, BKV has conducted numerous studies and projects⁸.
- 3) As for the product stewardship, we engage in projects and guidelines for the **product safety** of plastic materials, including recyclates which contain so-called legacy additives, see guidelines of the Federal Environmental Agency, Umweltbundesamt⁹. All plastic materials – not only primary-based, but also secondary-based (such as recyclates) – must fulfil the requirements of the chemicals legislation. This is necessary to ensure, without any compromises, the safety and quality of recyclates for the customer, also in sensitive areas such as food packaging.

At the same time, the requirements may not be unnecessarily exaggerated, hampering the use of the recycled material. Differentiated requirements may serve this purpose – e.g., for food and cosmetics contact. According to regulation (EC) No. 1223/2009 on cosmetic products, for example, producers may bring into circulation only products whose cosmetic application is safe. However, it has so far not been defined whether and under which conditions recyclates may be used. Where e.g. cosmetics or detergents or cleaning agents are placed on the market, this may cause uncertainty about whether and in which form recyclates comply with the requirements in the cosmetics sector. Thus in practice, typically food grade recyclates are used in such personal care products.

- 4) **Technology-open minded recycling:** We research and develop in a variety of areas: product design, mechanical recycling, and complementary chemical recycling, up to digitalisation. An intensified recycling will be successful only when addressing and solving constraints and challenges of recycling in the context of the entire waste management up to the utilisation as a secondary material. Therefore, it is necessary for both mechanical recycling and the complementary chemical recycling to fulfil quality criteria in order for the market to reward the materials which result from these recycling processes.

With regard to the chemical recycling process, the developments need to be continued in a way that the material-based use of the products gained from chemical processes, such as pyrolysis oil and gas serve to produce new plastics.

In waste management, the recovery of energy from plastics-containing waste is therefore regarded as a transitional technology, as it exploits the energy content, but not the carbon of the waste for the material recovery.

⁶ BDI concept paper – Industriekonzept zum möglichen Wertstoffgesetz (Industry concept for a potential materials legislation), Bundesverband der deutschen Industrie (German Industry Association), Berlin (2015)

⁷ C. Lindner, Stoffstrombild Kunststoffe in Deutschland 2019, Conversio Market & Strategy, Mainaschaff (2020)

⁸ www.bkv-gmbh.de/infothek/studien.html

⁹ REACH und Kunststoffrecycling – Handreichung für eine sachgerechte Umsetzung der REACH-Anforderungen für Betreiber von Recyclinganlagen, UBA-Texte 55/2011 (original version);

REACH and the recycling of plastics – Reference manual for an appropriate implementation of the REACH requirements for the operators of recycling plants, UBA-Texte 08/2012 (english edition)

- 5) In standardisation, certification, and approval testing, we engage in **recycling in line with quality requirements**. For this purpose, the organisational prerequisites have been established, e.g., at the German authorised standardisation committee, DIN “Plastics Committee” in Germany, and at the European Committee for Standardization, CEN, on a European level.
- 6) We support the establishment of **specific systems and industry solutions** resulting in high quality material streams for recycling such as Rewindo for the recycling of window profiles, ERDE for the return and recycling of agricultural film, return systems for industrial packaging or the CP system for the reuse of pallets in the chemicals industry.
- 7) We engage in the pan-European network of the plastics manufacturers and plastics value chain. As part of the voluntary commitment Plastics 2030¹, various **sector-specific commitments** on individual types of polymers have been formulated in co-operation between plastics manufacturers, converters, and recyclers, such as PCEP (Polyolefins Circular Economy Platform) for polyolefins, SCS (Styrenics Circular Solutions) for polystyrenes and foamed polystyrenes, or even VCS (Vinyl Circular Solutions) for PVC packaging materials.

The supply and the demand for recyclates must be balanced and further increased by means of market economy instruments

The use of recyclates in new materials and products is an important part of circular economy with plastics. For this purpose, several options and measures are to be taken into account.

Within industry, there is a series of developments going on, where the use of recyclates in certain products has been established, i.e. industry-driven solutions such as for boxes, buckets, flowerpots etc. The plastic raw material producers support the extension of using recycled plastics in these areas and are engaged within the frame of the comprehensive **voluntary industry commitment** at European scope¹ as explained above.

In Germany, **research activities** and initiatives are being performed not only by industry and academia but also by administration e.g. by the Federal Environmental Agency, the Federal Research Ministry and further regional and European cooperation programmes. The plastics manufacturers explicitly welcome that such product developments are being pushed.

By these engagements, markets for the use of recyclates in specific sectors and product applications will be developed and established, thus, circular economy with plastics made possible in practice. As for any product in a certain market, this is an individual task. It will be most effective, if a variety of measures are available and applied. In addition to industry activities, research and development, standardisation and certification etc., there are also certain provisions in legislation.

By means of **legislative rules**, a minimum recycled content has been set in a specific product application, the PET beverage bottles. These specific disposable bottles shall contain recycled PET as a minimum of 25 percent and 30 percent respectively, in a staged approach until 2025 and 2030, according to the EU Single Use Plastics Directive. Currently, this legislative rule is in the stage of its national transposition in Germany. Furthermore, the just revised German Waste Act¹⁰ requires the preference of using recycled materials in products used by the public procurement.

In addition to these two regulations there are current considerations to also introduce a new target for recycled content in the upcoming revision of the European Packaging and Packaging Waste Directive. PlasticsEurope would support a new European-wide target for recycled plastics in packaging as follows: 30% of recycled content in plastics packaging shall be achieved as a goal by 2030. In view of PlasticsEurope, such a high amount corresponds to a very ambitious target, knowing that the European average of recycled content in packaging amounts to just 5% today¹¹. There-

¹⁰ German Waste Act, i.e. “Kreislaufwirtschaftsgesetz – Gesetz zur Förderung der Kreislaufwirtschaft und Sicherung der umweltverträglichen Bewirtschaftung von Abfällen”

¹¹ C. Lindner, Circular economy of plastics 2018 EU-28 + 2, Market & Strategy, Mainaschaff (2019)

fore, **enabling conditions** are key to achieve such an ambitious set target. These conditions comprise several aspects like: closure of landfilling plastics-rich wastes in Europe as early as possible, support and collaboration of the full value chain, technology-neutral recycling procedures, well-defined and EU-wide harmonised measuring methodology, improving waste infrastructure, optimising sorting technology, free inner-EU shipment of qualified plastic waste destined for recycling within the EU, etc.

It is expedient, from a plastics manufacturers' perspective, that these targets and conditions should at first be proven against effective transposition and **practical experience** about the recycled content in the respective products, i.e. single-use beverage bottles, certain plastic packaging and public procurement appliances, respectively. Products and applications in other sectors like automotive, electrical/electronics, building and construction etc. will then benefit from these experiences, since targets for recycled content cannot be transferred one by one to other areas, products, or markets where frame conditions, infrastructures and handling are different. Therefore, it is important that individual research activities, voluntary schemes, standardisation etc. should be further elaborated. On this basis, it will be possible to optimise the uptake and use of recyclates by considering both innovation as well as complexity and variety of product demands and use in these specific areas.

For the target to increase the **market-driven recycled content** in new products, the three main criteria – quality, availability, and competitive prices – must be applied at the same time as for any other plastic material, too. For these requirements both ecological and market economy-based tools should be applied. As cross-the-board, undifferentiated, and unspecific content targets for the use of recycled material, particularly in legal provisions, do not generally provide a suitable solution for the quality and availability requirements of recyclates from market players. Other options, especially incentives or also voluntary initiatives, e.g., measures of individual product platforms, where also plastics manufacturers engage in as part of the value chain, see above, are more expedient from our perspective.

Due to highly complex and tedious processes as well as established recycling structures, value chains and markets, targets on a material level would limit quality, performance and innovation potential for the material and product development. For this reason, polymer-specific set targets for a recycled content are in general fully inadequate, because they would not be able to increase the uptake of qualified recyclates in practice. Also, the frame conditions and the principle of waste legislation are, in general, specific to product applications.

In general, a **European harmonised approach** should be aimed at from the outset. National targets are not an appropriate solution in view of plastic raw material producers.

With regard to a use of recycled materials in new products in line with market requirements, we consider the following prerequisites as constructive for an effective, efficient, and hence swift development:

- Clear criteria and specifications for the **quality requirements**. These are essentially independent of the resource. The requested material features and specifications must be ensured not only with the necessary quality, but also quantity and availability for the product users. This will guarantee that the engineers and designers of the relevant areas of application can employ qualified recycled materials that meet market needs.
- **Technology-neutral consideration** for current and future recycling processes and the resulting products, i.e., the recyclates, in order to:
 - a) serve the market in a flexible fashion; this requires a uniform and technology-neutral terminology of the term “recyclate”, see below, and
 - b) to contribute to the fulfilment of the recycling targets requested by law; this requires the legal recognition of both mechanical/physical processes and – supplementary – forward-looking, innovative chemical processes.
- Wider use of the possibilities offered by **digitalisation**, e.g., in material development by compounding for optimising the performance profile of plastic materials for a suitable product use in a specific field of application.

- The **collaboration of the stakeholders** involved across the waste management chain: recycling will be successful through mainly genuine and clean material flows. This can be achieved by informing consumers, collecting waste separately, and applying modern sorting technology. Even a **smart product design** can facilitate circularity.

On the basis of the plastic material flow⁷, the recycling and the production of halves ware and final end-products with recycled material are described in the figure, see below.

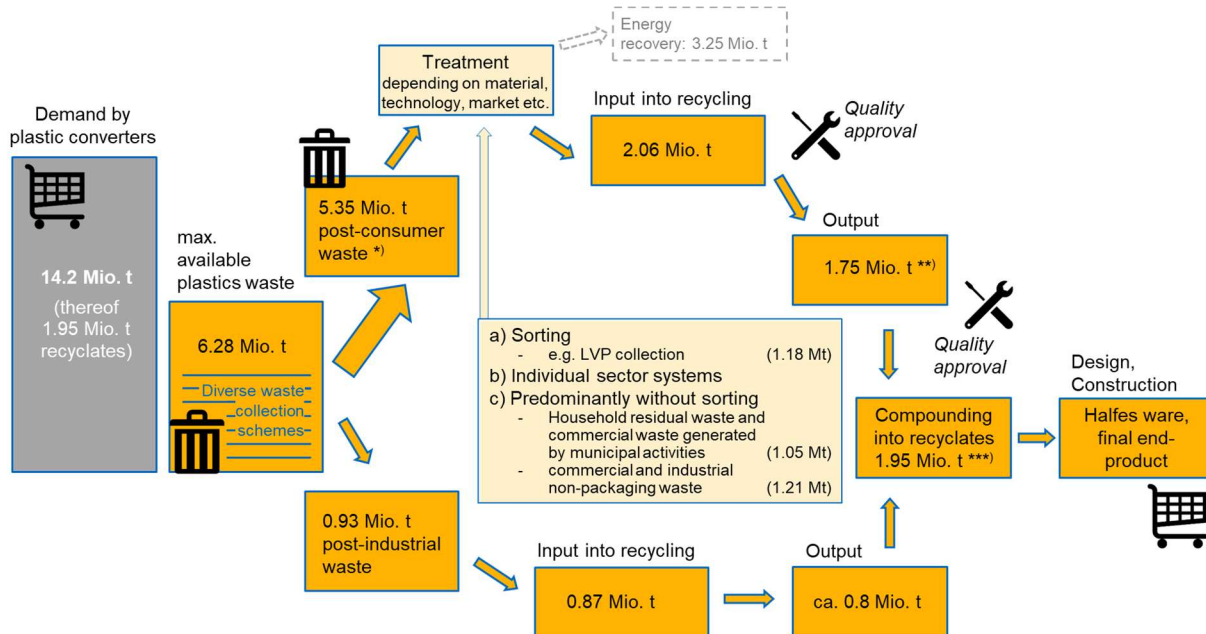


Figure: Schematic illustration of the processes of managing plastic-containing wastes and ways of producing recycled plastics (2019 data in Germany)

- *) 5.35 Mio. tons plastics are contained in 81.89 Mio tons of municipal solid waste
- ***) Out of 1.75 Mio tons 0.72 Mio. tons are exported for purpose to produce recyclates
- ***) These 1.95 Mio tons of compounded recyclates are demanded by converters

The simplified illustration shows the different types of plastic waste collection and treatment up to the manufacturing of recyclates by the compounders serving producers of halves ware and final end-products.

The starting point of the material flow is on the one hand side provided by the post-consumer waste collections of various material flows, i.e. via household waste collections and commercial waste collections, the latter generated mainly by municipal activities. On the other hand, there is post-industrial waste, which arises from raw material producers and converting industries. In total, approx. 6.3 million tonnes of plastics are collected from these waste streams.

The waste collection is followed by different types of waste treatment with various processing procedures and, where appropriate, sorting for specific material fractions. Based on the type of material, infrastructure in private-sector and municipal organisation, available technology, and downstream processes and markets, various types of treatment have been established in different fields. The management of plastics-containing waste is integrated in this complex structure of municipal waste treatment.

In this way, the collected plastic containing wastes are treated and processed to recyclates which are taken up by the producers of end-products. According to the present data survey conducted by Conversio⁷, the amount of compounded recyclates sums up to 1.95 million tonnes in Germany. This corresponds to 31% related to the total amount of generated plastics waste (i.e. 6.28 million tonnes). This amount corresponds to 14% to the total demand of the plastic converters (i.e. a total of 14.2 million tonnes).

To achieve the necessary quantity of recyclates in certain products, it needs to be considered that significant streams of plastic waste relevant in practice are basically not accessible for the recycling, as they are, for example, collected as residual waste (so-called “schwarze Tonne”, i.e., black

bin, in Germany) or mixed commercial waste, and predominantly used for energy recovery. These two waste streams alone, account for 42% of the 5.35 million tonnes of plastic end-user waste. Here, sorting is neither intended nor economically sensible at present, as its percentage share of the relevant material flow is too low (approx. 2% to 6%). Though, these streams contribute to relevant quantities with respect to plastics (each about 1.0 to 1.2 million tonnes). An increased citizen information and awareness raising can certainly be helpful here. At a certain point, however, it should realistically be recognised that the good and right measures have evidently not yielded sufficiently in the past.

The management of the plastics waste value chain in practice also shows that the mechanical recycling is restricted in terms of complexity and quality requirements, as this operation typically depends on well sorted and clean waste collection and preparation. For this reason chemical recycling is proposed as a complementary recycling option to the mechanical recycling especially for those material streams that are treated by energy recovery which presently is still frequently used. Even, there are material streams which are currently being sent to energy recovery without sorting. Since the chemical recycling cannot yet be made available in a relevant economy-of-scale today, intensive research and development need to be performed.

The central aspect for the recycling of plastic waste is the quality requirements and audits of the relevant plastic fractions, including the recyclate compounded up to the last stage, which is demanded by the market with defined product and material specifications. This is why the demand of the end-producers represents the key driver for the use of a recyclate.

For the recycled materials to be purchased by the converters and users from the production industry, such as suppliers, OEMs, brand owners etc., and hence establish itself in the market by being used in products, the fulfilment of the material specifications as well as the environmental and quality standards are the main prerequisites. To this end, a series of norms and standards have been established, such as the European series of standards EN 15342 seq., which characterise recyclates of individual types of polymers or rate the conformity of the recyclate etc. Moreover, quality and test specifications of the RAL are available, as well as certification programs, e.g., at TÜV, PÜG, or Dekra. Finally, the material specifications are tested also by end producers in terms of their suitability for the relevant application¹². Among other things, this also includes the presentation of product and material data sheets in accordance with the REACH and CLP regulations, which are nowadays a prerequisite for the marketability of materials. Today, not only the relevant standards and certifications, but also the concomitant detailed documentation is an integral part of the contracting partners between material suppliers and their customers.

Furthermore, the survey of the plastics flow of Conversio⁷ shows that, from the recycled materials converted in 2019, about two thirds have been demanded by the construction sector (43%) and the packaging industry (24%). The use of recyclates in technical applications, i.e., automotive and electrical/electronics industry jointly accounts for only 6 percent. This proves the general need to fulfil the requested material specifications and qualities, and the same applies to recyclates.

In view of these explanations, the following aspects for the **definition of “recyclate”** need to be taken into account.

- The production and use of recyclates must be **based on material recovery**, i.e. recycling. This means that mechanical as well as chemical recycling processes can produce recyclates, if the product of the respective process is used for material recovery and not for energy recovery. Here, it is not relevant in which products the recyclate is used in terms of material recovery, i.e., it does not need to be used in products comparable to its “first life”. For this purpose, the German legislator already established the following technology-neutral definition in Article 3, Section 7b of the German Waste Act (Kreislaufwirtschaftsgesetz), consistently with the recycling definition of the EU Waste Framework Directive: *„Rezyklate im Sinne dieses Gesetzes sind sekundäre Rohstoffe, die durch die Verwertung von Abfällen gewonnen worden sind oder bei der Beseitigung von Abfällen anfallen und für die Herstellung von Erzeugnissen geeignet sind.“* (Within the meaning

¹² Qualitätssicherung für Kunststoffrezyklate durch Normen (Quality assurance for recycled plastic materials via standards), BDE, bvse, GKV, PlasticsEurope Deutschland, VDMA, Berlin/Bonn/Bad Homburg, 24th February 2014

of this Act, recyclates include secondary raw materials gained from the recovery of waste or that accrue when disposing of waste and that are suitable for the manufacturing of products.)

The definition has been deliberately selected in a broad sense by the German legislator in order “to determine neither the origin nor the concrete eligibility criteria of the recyclates¹³”. We would welcome, if this technology-neutral definition for clarifying the term ‘recyclate’ would also be transposed into EU legislation. And this definition should also be adopted in the German Packaging Act or, respectively, be secured that there is no deviating definition from the superior Waste Act which might restrict any technology-neutral recycling.

- The origin of the carbon shall be defined and used **independently from its raw material**. Therefore, the production of a recyclate is generally suitable from all types of suitable material streams, be it from the collection of post-industrial waste or post-consumer waste or combinations thereof. Thus, the recycling and hence also the production of recyclates must be accessible from all waste sources, as the quality and material specifications of the recyclate is the decisive factor, and not its origin¹⁰.
- The production of recyclates shall generally be enabled and acknowledged in a **technology-neutral** way, i.e., for both the mechanical and complementing chemical recycling procedures.

For the communication of a recycled content where a recyclate is used in an end-user product, we recommend applying standards and, where appropriate, certification programmes, e.g., for energy-relevant products in electric/electronics, the standard EN 45557 “*General method for assessing the proportion of recycled material content in energy-related products*”. Further standards are being developed in the plastics standardisation committees in Germany and Europe at DIN¹⁴ and CEN¹⁵. Important for the communication about the recycled content are the proof of and compliance with harmonised rules across Europe for the chain of custody of the use of a recyclate, e.g., with the mass balance model.

Conclusion: increased use of recycled materials in line with market needs for the circular economy

The plastics manufacturers stick to the objective of a future greenhouse gas-neutral production with the commitment to a complete and sustainable circular economy with plastics. In order to achieve this aspirational target, the present efforts need to be stepped up significantly. Taking into consideration the complex structure of the market and the need to retain the product safety and high level of environmental protection, manifold measures will be required to further enhance the circular economy including an increased use of recyclates as described above: product design, technology-neutral recycling procedures etc. Particular prerequisites for an increased use of recyclates include the availability of the secondary materials and the fulfilment of the recyclate’s quality. These conditions will make sure that the engineers and designers can use qualified recyclates that ultimately comply with the requirements of the relevant end-user products in the market.

Frankfurt, 29 June 2021
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¹³ Die Novellierung des Kreislaufwirtschaftsgesetzes 2020 (The review of the German Waste Management Act 2020), NZVR, 1-2/2021, Petersen/Friedrich, p.1 et seq., 15.1.2021.

¹⁴ see National standardisation at DIN/NA 054-03-03 AA “Recycling of plastics in the circular economy“ with published standards and projects: www.din.de/de/mitwirken/normenausschuesse/fnk/nationale-gremien/wdc-grem:din21:309198655

¹⁵see European standardisation at CEN/TC 249/WG 11 “Plastics Recycling” with published standards and work programmes: https://standards.cen.eu/dyn/www/f?p=204:7:0:::FSP_LANG_ID,FSP_ORG_ID:25,410327&cs=1D8D0A7928FAC2D05F16205FEB4C1711F#1