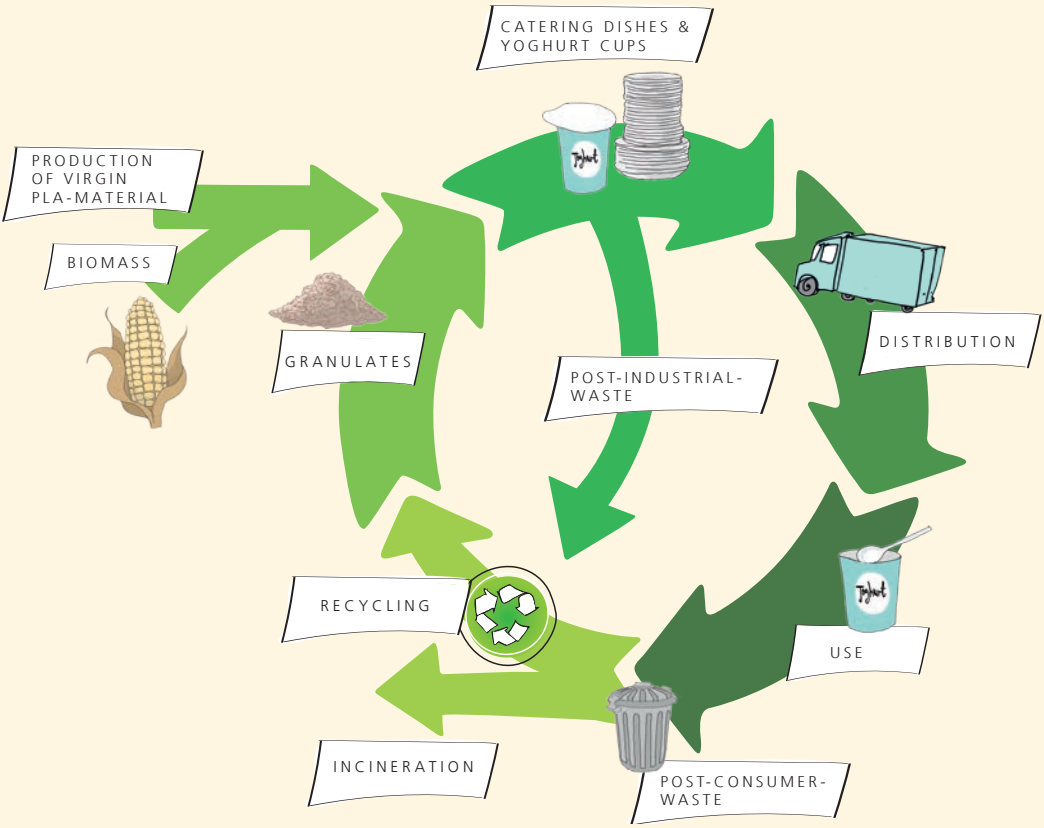
RESULTS SUMMARY

PLA IN THE WASTE STREAM



With support from

Federal Ministry of Food and Agriculture

by decision of the German Bundestag

Project managing organization

FNR

Fachagentur Nachwachsende Rohstoffe e.V.

INTRODUCTION

For more than two decades, a working recycling system for lightweight packaging made of plastic in Germany has been established.

In 2015, approx. 5.9 million tons of plastic waste were collected, of which 45 % was recycled and 53 % was used for energy recovery. Feedstock recycling accounted for 1 % and 1 % has been disposed of or landfilled. Recycling means sorting and cleaning plastic waste in order to produce thermoplastic re-granulates, which are used in manufacturing new products, predominantly in the building sector (approx. 38 %), in the packaging industry (approx. 25 %) and in agriculture (approx. 10%)[1].

The increasing use of bio-based plastics results in partially new types of material entering into the established ways of plastic waste management. In this context, a number of questions regarding sensible use and efficient recycling of these new and valuable materials arise.

In Paragraph 21, the new German packaging act, which becomes effective on January 1, 2019, states that participation fees for packaging shall provide incentives to promote: 1. the use of materials and material combinations that can be recycled as much as possible, considering the practice of sorting and recycling, and 2. the use of recyclates as well as of renewable resources[2]. These regulations increase the opportunities for new packages designed for recycling, being made of recycled raw materials as well as from renewable resources.

Eight organizations worked on the example of polylactide (PLA) as selected bio-based plastic with novel chemical structure focusing on its disposal, sorting and up-grading to recyclates. PLA-wastes originating from industrial processes as well as from post-consumer waste collection were studied.

For this project, KNOTEN Weimar GmbH generated PLA waste in an industrial sorting plant: PLA packaging was mixed with light weight packaging waste, and was separated via near infrared spectroscopy (NIR) sorting. Subsequently, the PLA fraction was shredded and washed. The resulting post-consumer PLA waste consisted of: 73.4 % PLA, 20.1 % paper including dust, 5.2 % polyolefins and 1.3 % PET. Apart from post-consumer waste, industrial PLA waste was investigated. The research alliance tested the feasibility of material and feedstock recycling processes accompanied by life cycle assessments.

The following results summary consists of statements on bioplastics recycling and relates them to the findings of the research alliance.

presented by
Partners of the BMEL (Ministry of Food and Agriculture) research alliance: Sustainable recycling strategies for products and wastes from biobased plastics

Information regarding the projects:
www.fnr.de/projektfoerderung/projekte-und-ergebnisse/projektverzeichnis

Funding codes
22010814 22031312
22031812 22012414
22019212

KEY MESSAGES AND FINDINGS

1 "Presently, conventional, fossil-based and bio-based plastics are recycled"

Today, material recycling of fossil-based plastics reaches a quota of approx. 45 %, where the share of recyclate in packaging material accounts for about 25 %[1]. There is significant potential to increase the recyclate share. Furthermore, the new packaging act stipulates an increase of recycling rates. Separately collected plastic waste materials, packages designed for easy recycling, a good separation at the waste source and a reliable sorting are essential to reach that aim.

Current experience already reveals that significantly higher rates of material recycling can be realized with unmixed material collection. In 2015 for example, Polyethylene terephthalate (PET) used for beverage bottles reached recycling rates of approx. 94 %[3].

Bio-based plastics with identical chemical structures, e. g. the partially bio-based PET (Bio-PET) or the near 100 % bio-based polyethylene (Bio-PE), pass the same recycling processes like their fossil-based counterparts and are also recycled with high rates.

2 "Production wastes are recycled"

Production wastes of bio-based plastics are recycled to a great extent just as production wastes of fossil-based plastics. This is true e. g. for production waste from injection molding or thermoforming (e. g. of yoghurt cups).

3 "NIR identification and sorting of bio-based plastics from mixed post-consumer packaging waste is possible"

This is confirmed by producers of sorting machines and by the results of the research alliance. However, sorting is not economical today due to the low amounts of PLA material in the post-consumer plastic mix.

4 "Bio-based plastics do not interfere with the recycling of conventional fossil-based plastics"

This statement needs a differentiated consideration. The project results of the Technical University of Chemnitz show that neither shares of up to 3 weight percent of PLA waste do disturb two investigated post-consumer PP recyclates does disturb, nor does it with up to 10 % PLA negatively influence PS re-granulates. However, other investigated polyolefin recyclates show incompatibilities with PLA and higher proportions of PLA may also lead to problems.

On the other hand, these higher proportions would encourage adjusting the sorting systems to separate PLA as this additional process step would become more economically viable.

5 "Recycling of bio-plastics is environmentally beneficial"

The life cycle assessment study prepared by Fraunhofer UMSICHT did confirm this statement. Mechanical as well as feedstock recycling of PLA contribute to a reduction of environmental impacts, because the recycled plastic can be used to substitute virgin material. The resulting savings in biomass production, fertilization and harvesting yield advantages for e. g. the environmental impact categories of land use, eutrophication and acidification. In addition, the substitution of virgin material saves greenhouse gas emissions and reduces the primary energy demand from non-renewable resources.

According to the life cycle assessment, the environmental impacts of the recyclates in many investigated categories are clearly lower than that with virgin material. Furthermore, the recycling of PLA waste shows environmental benefits in almost all investigated environmental impact categories compared to its application for energy recovery.

6 "Products from recycled PLA meet market demands"

The application of recycled PLA materials depends on product requirements, their

use as well as on the type of plastic (analogous to conventional plastic materials). The gardening and agriculture sector e. g. usually has lower demands than the automotive or packaging sector. This was proven by experiments at IfBB.

It depends on the plastic type and the intended use of the recyclates whether impurities like label residues disturb or whether they can be tolerated. This is similar to processing fossil-based plastic wastes. In addition, it is common practice to mix re-granulates with the corresponding new material in order to guarantee a reliable product manufacturing.

7 "Feedstock recycling of PLA is technically possible and can replace virgin materials"

The research alliance studied the integration of recycled PLA in the PLA synthesis process. The results show that this is a possible alternative to mechanical recycling, because it generates a material with the same quality as the virgin material. In this feedstock recycling, the used PLA material is split up into the intermediate product of dilactide. Fraunhofer IAP established the scientific and technical bases for feeding approx. 10 % PLA into the PLA synthesis process and applied the results in the joint project to post-industrial PLA waste.

8 "Solvent-based recycling yields high quality PLA"

The research alliance adapted the solvent-based recycling process to post-consumer PLA waste. The results of Fraunhofer IVV and Fraunhofer WKI show that PLA recyclates can be produced from a heterogeneous waste mix with ~ 30 % impurities by implementing the CreaSolv® process (CreaSolv® is a registered trademark of the CreaCycle GmbH in Grevenbroich). There was no indication for significant differences towards virgin material with regard to injection molding tests. Depending on the cleaning effort, recyclates can be manufactured in different colors ranging from various shades of green to colorless.

With an approx. 50 % higher yield there is a substantial economic advantage of this recycling alternative to conventional material recycling, because the process does not require previous pre-treatment steps of density separation and air separation.

9 "The mechanical recycling of PLA wastes easily tolerates impurities up to 5 %"

Paper as impurity poses a special challenge for the PLA recycling, because it contains a high share of humidity and other components, like printing inks which become incorporated into the PLA-recyclate. Another problem is the low paper density leading to higher waste volumes. PLA waste with such "problematic" contaminants of up to 5 % (like other plastics) can be successfully processed and granulated in common melt filtration systems (proven by tests of the Technical University of Chemnitz and IfBB).

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[1] *Consultic: Produktion, Verarbeitung und Verwertung von Kunststoffen in Deutschland 2015, Short version:* ***www.plasticseurope.de/cust/documentrequest.aspx?DocID=67654****; Slide 17 and 18; last accessed: 20 October 2017*

[2] *Verpackungsgesetz (German Packaging Act): Gesetz über das Inverkehrbringen, die Rücknahme und die hochwertige Verwertung von Verpackungen; July 2017*

[3] *GVM: Aufkommen und Verwertung von PET-Getränkeflaschen in Deutschland 2015;* ***www.forum-pet.de/rs/d/2016_09_22_Bericht_Verwertung%20PET-Getränkeflaschen%202015.pdf****; Slide 30; last accessed: 23 October 2017*

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As of October 12, 2017