Data for 2018

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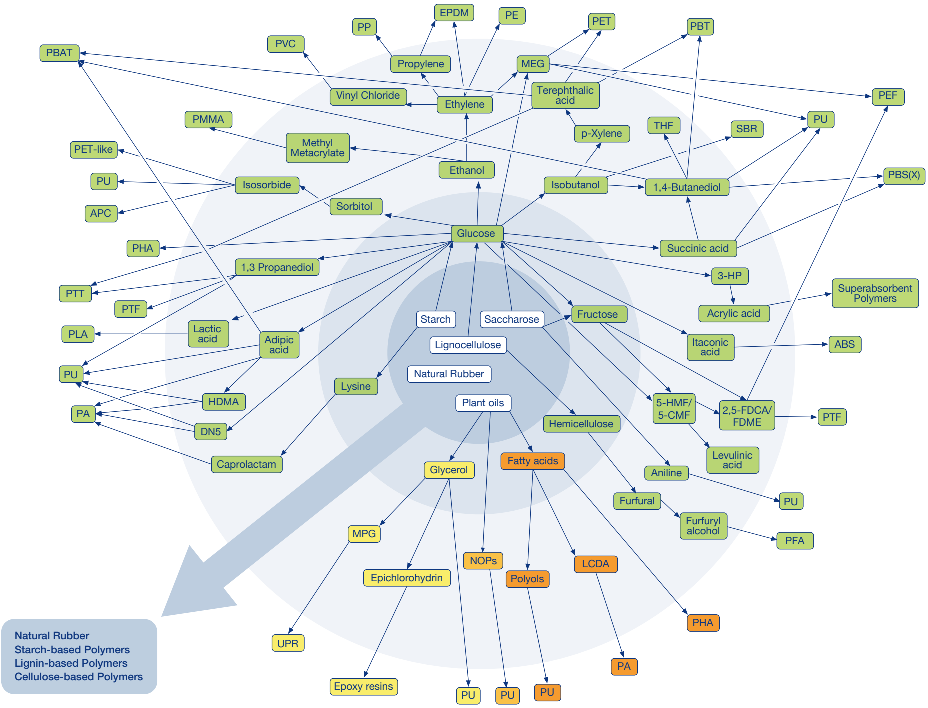
Bio-based Building Blocks and Polymers – Global Capacities, Production and Trends 2018–2023



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February 2019

This is the short version of the market study (380 pages, € 3,000). Both are available at **www.bio-based.eu/reports.**

Imprint

Bio-based Building Blocks and Polymers – Global Capacities, Production and Trends 2018–2023

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Table of Contents

Global Markets and Trends of Bio-based Building Blocks and Polymers 2018–2023

Global Markets and Trends of Bio-based Building Blocks and Polymers 2018–2023

Executive summary

2018 was a very good year for bio-based polymers: Several additional capacities were put into operation.

The new market and trend report "Bio-based Building Blocks and Polymers – Global Capacities, Production and Trends 2018–2023" from the German nova-Institute shows capacities and for the first time also production data for all bio-based polymers. In 2018 the total production volume reached 7.5 million tonnes – these are already 2% of the production volume of petrochemical polymers. The potential is much higher, but is currently hampered by low oil prices and a lack of political support.

The production of bio-based polymers has become much more professional and differentiated in recent years. By now, there is a bio-based alternative for practically every application. The capacities and production of bio-based polymers will continue to grow with an expected CAGR of about 4% until 2023, almost at about the same rate as petrochemical polymers and plastics Therefore, the market share of bio-based polymers in the total polymer and plastics market remains constant at around 2% (Figure 1).

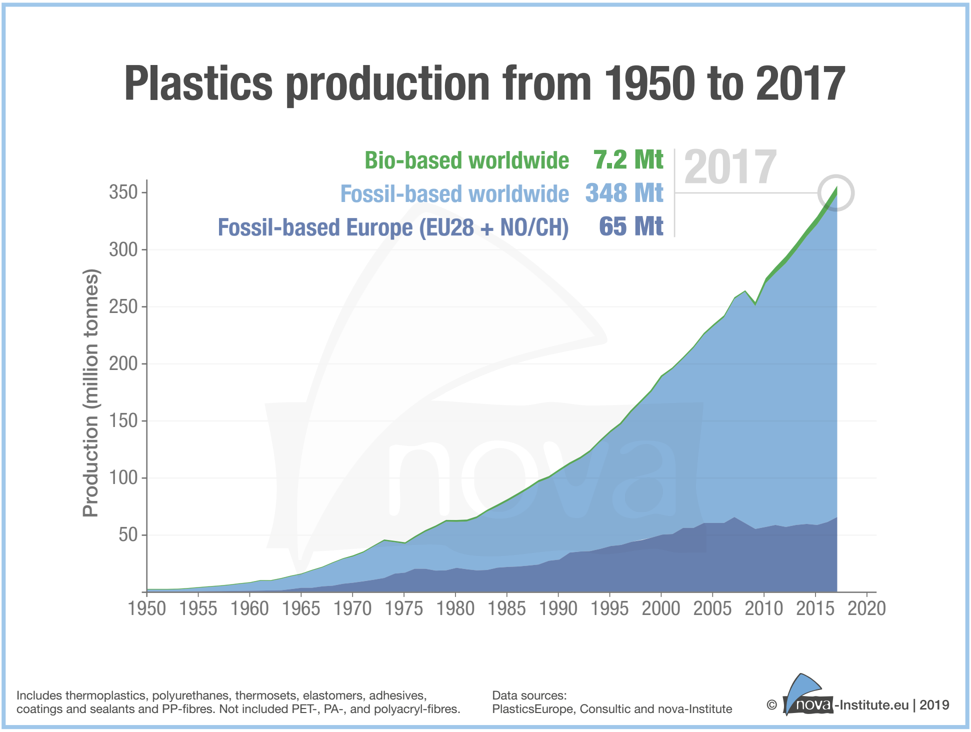

Figure 1: Plastics production from 1950 to 2017 (nova-Institut 2019)

The increase in production capacity is mainly based on the expansion of the polylactic acid (PLA) production in Thailand, the polytrimethylene terephthalate (PTT) and starch blends in US. Especially PLA and starch blends will continue to grow significantly until 2023. Also new capacities of bio-based polyamides, polyethylene (PE) and, for the first time, polypropylene (PP) and poly(butylene adipate-co-terephthalate) (PBAT). The great hopeful polyethylene furanoate (PEF) will presumably only be able to offer commercial capacities after 2023.
Overall, the market environment remains challenging with low crude oil prices and little political support.

- So far, the two major advantages of bio-based polymers have not been politically rewarded. The first advantage is that bio-based polymers replace fossil carbon in the production process with renewable carbon from biomass. This is indispensable for a sustainable, climate-friendly plastics industry and is not yet politically rewarded.

- The second advantage is offered by about a quarter of bio-based polymer production: They are biodegradable (depending on the environment) and can therefore be a solution for plastics that cannot be collected and enter the environment where they can biodegrade without leaving behind microplastics. Only a few countries such as Italy, France and, in future probably Spain will politically support this additional disposal path.

The most important market drivers in 2018 were brands that want to offer their customers environmentally friendly solutions and critical consumers looking for alternatives to petrochemicals. If bio-based polymers were to be accepted as a solution and promoted in a similar way as biofuels, annual growth rates of 10 to 20% could be expected. The same applies as soon as the price of oil rises significantly. Based on the already existing technical maturity of bio-based polymers, considerable market shares can then be gained.

The market report is updated every year and the update for the year 2018 offers very special highlights: It contains comprehensive information on capacity development from 2018 to 2023, per bio-based building block and polymer and for the first time production data for the year 2018, per bio-based polymer. A total of 17 bio-based building blocks and 16 polymers are covered in the report. In addition, the new issue includes analyses of market developments and producers per building block and polymer, so that readers can quickly gain an overview of developments that go far beyond capacity and production figures. For the first time, a detailed research, calculation and explanation of the market development of cellulose acetate (CA), bio-based epoxy resins and bio-based polyurethanes was made possible through a cooperation with the main experts in this area. The deep dive into the producing companies was comprehensively updated and shows now 173 detailed company profiles – from start-ups to multinational corporations.

The data published annually by European Bioplastics ***(www.european-bioplastics.org/market/)*** are taken from the market report of the nova-Institute, but with a reduced selection of bio-based polymers.

Bio-based Polymers

Figure 2 shows all commercially realized pathways from biomass via different building blocks and monomers to bio-based polymers. As in previous years, we have added several pathways and some new intermediates.

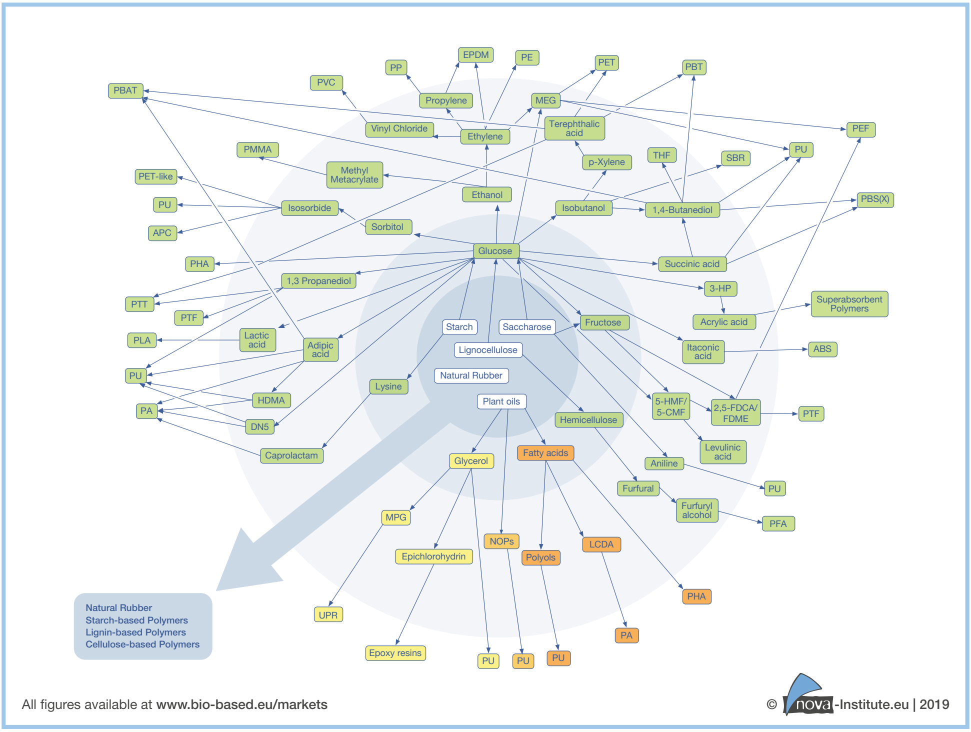

Figure 2: Pathways to bio-based polymers (nova-Institut 2019)

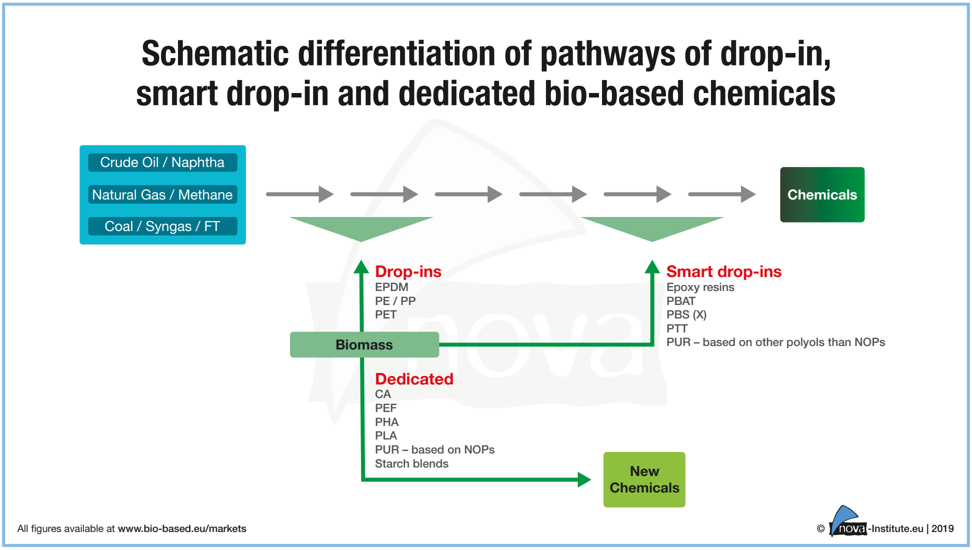

Figure 3: Schematic differentiation of pathways of drop-in, smart drop-in and dedicated bio-based chemicals.[1] Selected bio-based polymer examples are shown for each classification group.

Figure 3 shows the different pathways of bio-based "drop-in", "smart drop-in" and "dedicated" inputs within the chemical production chain. For each group certain bio-based polymers are exemplarily shown. The different bio-based polymer groups are subject to different market dynamics. While the drop-ins have direct petrochemical counterparts and can substitute them, the dedicated ones have new properties and functionalities that petrochemistry does not provide. Both have their own advantages and disadvantages from a production and market perspective.

Figure 4 summarises the results of the results of the 380-page report and shows the development of capacities from 2018 to 2023 on the basis of forecasts by current and some additional producers. Here an increase is shown from 8 Mio. tonnes production capacity in 2018 to 9.6 Mio. tonnes in 2023, which means an expected yearly growth rate of about 4% (CAGR).

With an expected CAGR of 10% between 2018 and 2023, Europe will display the highest growth of bio-based polymer capacities compared to other regions of the world (see Figure 7).
If only the new dedicated polymers (for definition see Figure 3) are considered, the growth rates are expected to be even higher (CAGR = 5%), as Figure 5 shows. In the group of dedicated bio-based polymers, price pressure stemming from cheap crude oil is lower than for other groups because there are no direct petrochemical counterparts.

1 **Source:** Carus, M. et al.: Bio-based drop-in, smart drop-in and dedicated chemicals. Version 2017-12. Free download at: **www.bio-based.eu/technology**).

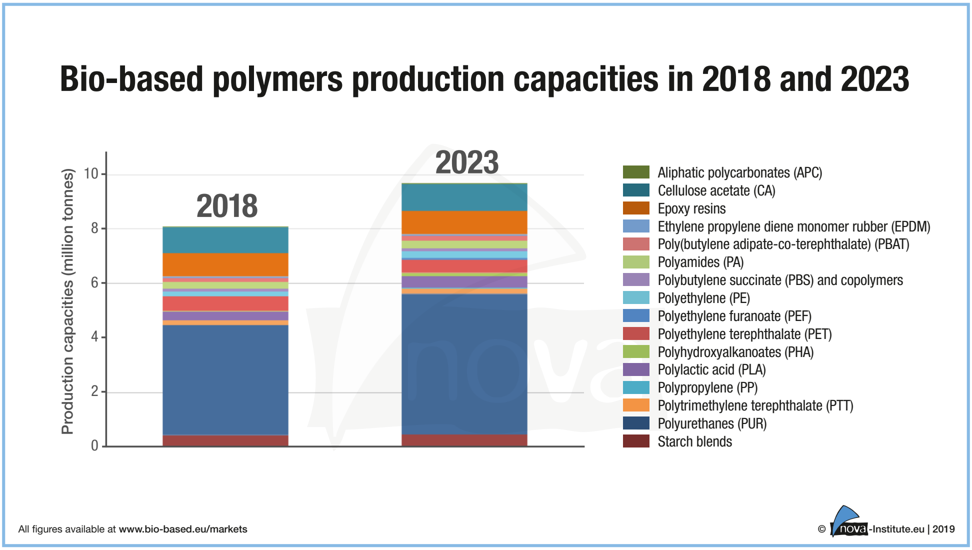

Figure 4: Bio-based polymers production capacities in 2018 and 2023

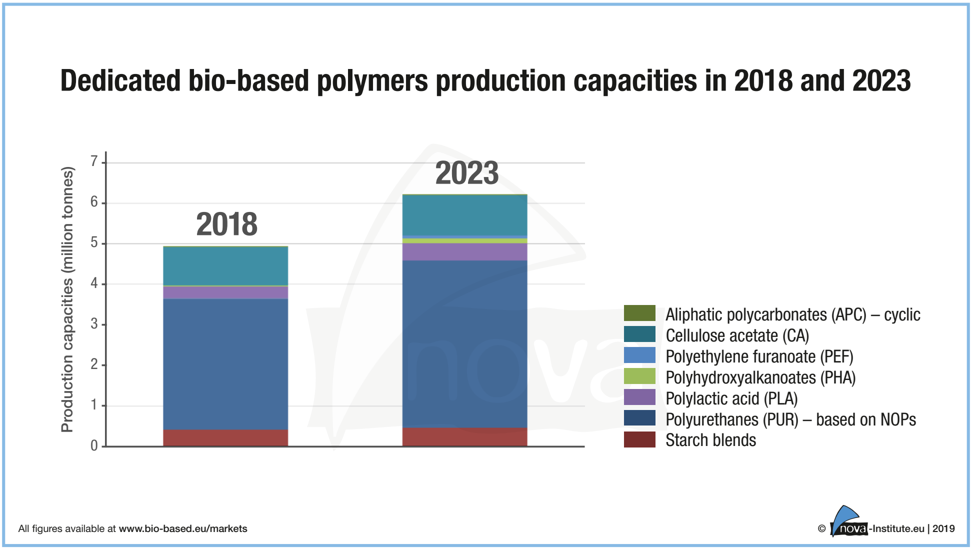

Figure 5: Dedicated bio-based polymers production capacities in 2018 and 2023

Bio-based Building Blocks

Figure 6 illustrates the development of capacities for the main bio-based building blocks, the core of the new bioeconomy, used for the production of polymers. Between 2018 and 2023, the CAGR of 4.5% will be only slightly higher than that of bio-based polymers (4%) as a whole.

The building blocks can be used in structural polymers as well as in functional polymers (for definition see below) and also in various other applications such as food, feed, cosmetics or pharmaceuticals.

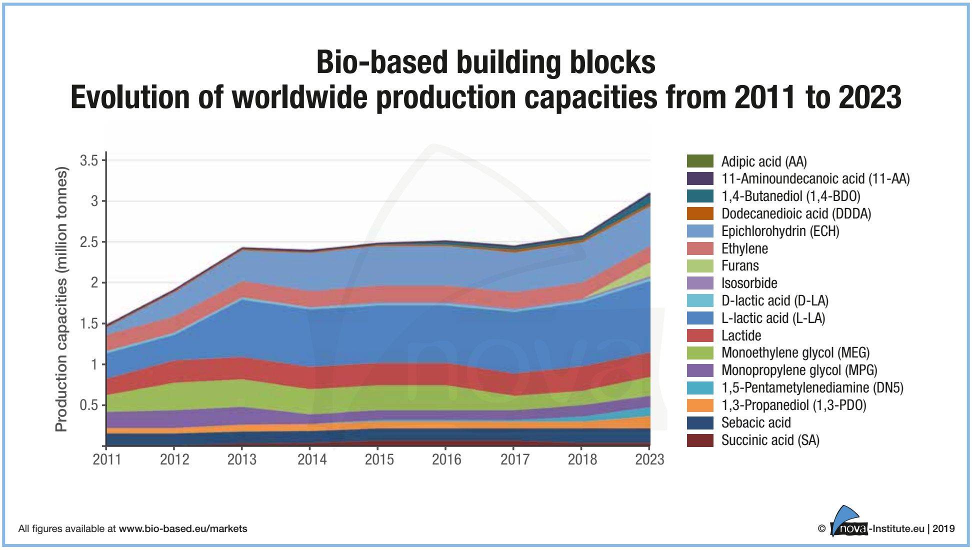

Figure 6: Bio-based building blocks – Evolution of worldwide production capacities from 2011 to 2023

The overall production capacity of bio-based building blocks increased about 5% (120,000 t/a) in 2018, although some pioneers went bankrupt. The overall forecast for bio-based building blocks evolution worldwide indicates a total growth by 4.5% until 2023 with 1,3-propanediol (1,3-PDO), 1,4-butanediol (1,4-BDO), 1,5-pentamethylenediamine (DN5) and 2,5-furandicarboxylic acid (2,5-FDCA)/furan dicarboxylic methyl ester (FDME) being the main drivers.

Global production capacities of bio-based polymers by region

Besides the leading Asian region which has installed the largest bio-based production capacities worldwide with 53% in 2018, Europe follows with 18% and North and South America with 17% respectively 11%. In the next five years, the share of Europe will rise to 25% until 2023 – all other regions will face decreasing shares (see Figure 7).

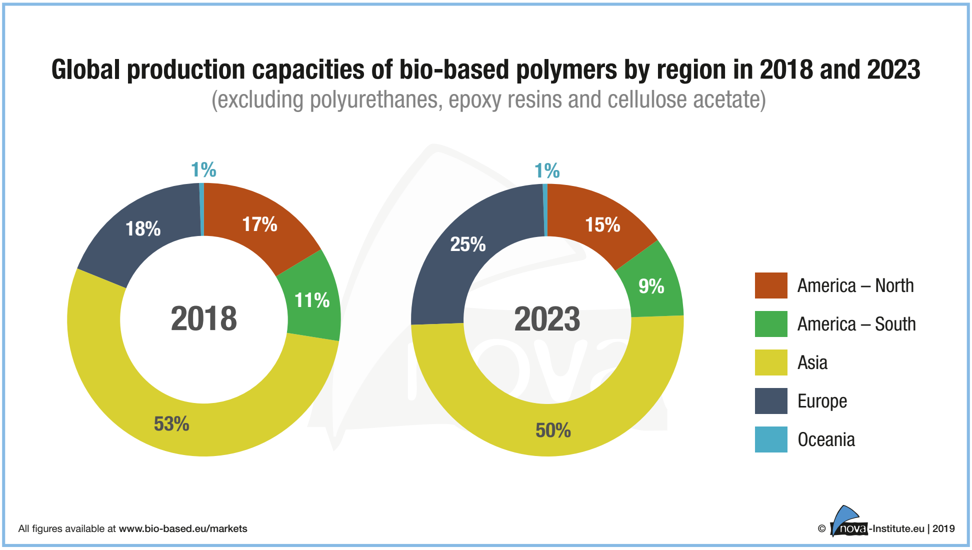

Figure 7: Global production capacities of bio-based polymers by region in 2018 and 2023 (excluding polyurethanes, epoxy resins and cellulose acetate)

This increase is mainly due to the dedicated bio-based polymers PEF, PHA, PLA and starch blends as well as the new established bio-based production capacity of PP, the increase in PE capacity and an increase in polyamides and PBAT.

This shows that the substantial investment in research and development in Europe is bearing fruit. Now, if the political framework were designed more favourably, the bioeconomy in Europe could really flourish. Technology and business are ready.

Market segments for bio-based polymers

Today, bio-based polymers can be used in almost all market segments and applications, but the applications per polymer are very different. Figure 8 shows a summary of the applications for all polymers.

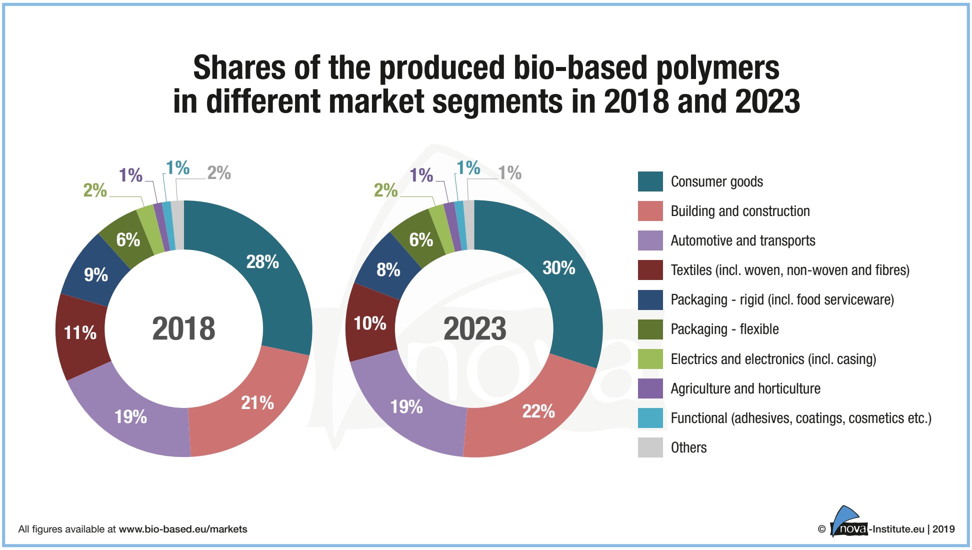

Figure 8: Shares of the produced bio-based polymers in different market segments in 2018 and 2023

Consumer goods make up the largest share of actually produced bio-based polymers with 28% in 2018 (mainly PUR, epoxy resins and PA), followed by the building and construction sector (epoxy resins, PA, PUR) with 21%, the automotive and transport sector with 19% (epoxy resins, PA, PUR) and the packaging (flexible and rigid) (PLA, PBAT, PE, PET, starch blends) with 15%, as well as textiles (wovens and non-wovens) (CA, PA, PLA, PTT) with 11%. For 2023, no significant changes are expected with regard to market application shares.

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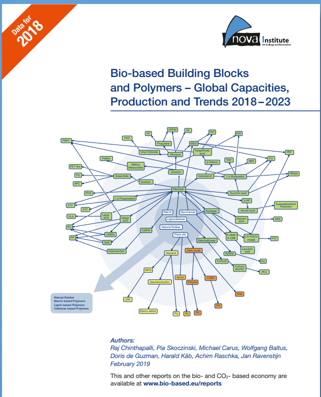
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Bio-based Building Blocks and Polymers – Global Capacities, Production and Trends 2018–2023

Authors: Raj Chinthapalli, Pia Skoczinski, Michael Carus, Wolfgang Baltus, Doris de Guzman, Harald Käb, Achim Raschka, Jan Ravenstijn
February 2019

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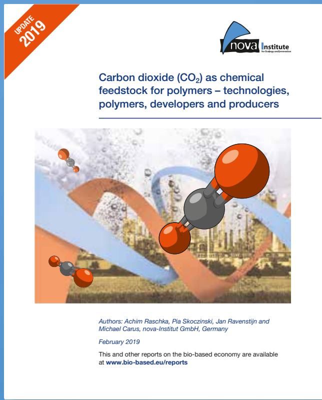
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Carbon dioxide (CO_2) as chemical feedstock for polymers – technologies, polymers, developers and producers

Authors: Achim Raschka, Pia Skoczinski, Jan Ravenstijn and Michael Carus, nova-Institut GmbH, Germany
February 2019

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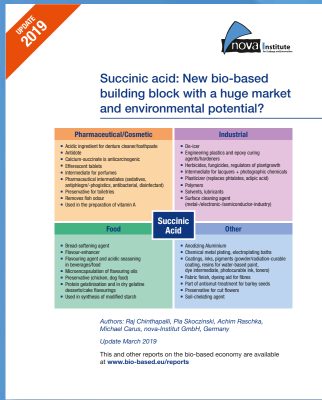
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Succinic acid: New bio-based building block with a huge market and environmental potential?

Authors: Raj Chinthapalli, Pia Skoczinski, Achim Raschka, Michael Carus, nova-Institut GmbH, Germany
Update March 2019

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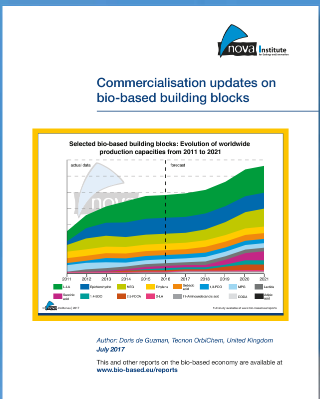
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Commercialisation updates on bio-based building blocks

Author: Doris de Guzman, Tecnon OrbiChem, United Kingdom
July 2017

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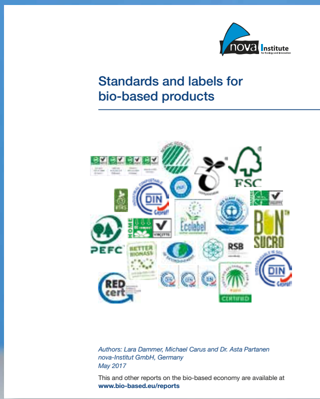
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Standards and labels for bio-based products

Authors: Lara Dammer, Michael Carus and Dr. Asta Partanen nova-Institut GmbH, Germany
May 2017

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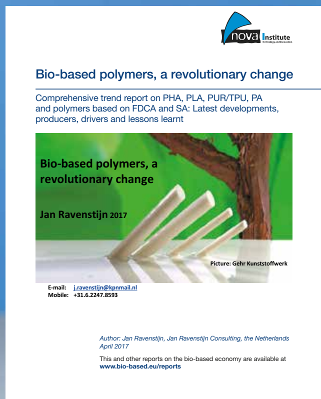
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Bio-based polymers, a revolutionary change

Comprehensive trend report on PHA, PLA, PUR/TPU, PA and polymers based on FDCA and SA: Latest developments, producers, drivers and lessons learnt

Author: Jan Ravenstijn, Jan Ravenstijn Consulting, the Netherlands
April 2017

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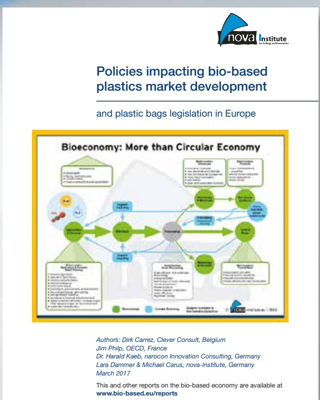
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Policies impacting bio-based plastics market development

and plastic bags legislation in Europe

Authors: Dirk Carrez, Clever Consult, Belgium
Jim Philp, OECD, France
Dr. Harald Kaeb, narocon Innovation Consulting, Germany
Lara Dammer & Michael Carus, nova-Institute, Germany
March 2017

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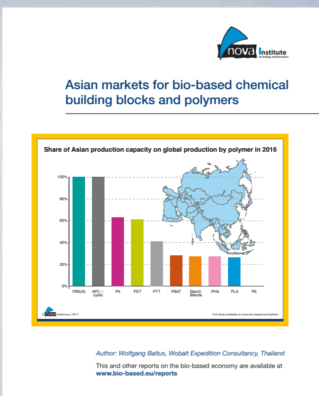
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Asian markets for bio-based chemical building blocks and polymers

Author: Wolfgang Baltus, Wobalt Expedition Consultancy, Thailand

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Market study on the consumption of biodegradable and compostable plastic products in Europe 2015 and 2020

A comprehensive market research report including consumption figures by polymer and application types as well as by geography, plus analyses of key players, relevant policies and legislation and a special feature on biodegradation and composting standards and labels

Bestsellers

Authors: Harald Kaeb (narocon, lead), Florence Aeschelmann, Lara Dammer, Michael Carus (nova-Institute)
April 2016

The full market study (more than 300 slides, 3,500€) is available at bio-based.eu/top-downloads.

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Authors

Raj Chinthapalli has Masters in Chemical and Process Engineering from Ott-von-Guericke Universität, Magdeburg, Germany, he joint nova-Institute's Department of Technology and Markets in 2017. He hast extended work experience in market research and technology analysis. His interests are mainly in addressing the bio-based chemical and polymer markets, for the entire value chain from feedstocks to the end user industry.

Pia Skoczinski (PhD) is trained as a biologist, has several years of research experience in optimization of microbial cell factories, enzyme engineering and enzyme-catalyzed polymerization. After receiving her PhD in biology in 2016 from the Heinrich Heine University of Duesseldorf, she did a one-year postdoctoral research at the University of Groningen in Macromolecular and Polymer chemistry. Since April 2018 she is working at nova-Institute in the Technology & Markets department and is focused on bio-based building blocks and polymers, Industrial Biotechnology and Carbon Capture and Utilization.

Michael Carus, Physicist, from 1983 to 1994, he worked for the IT industry, environmental institutes and the solar industry. In 1994, he co-founded nova-Institute and has been functioning as owner and Managing Director since then. More than 15 years experience in the field of bio-based economy, including work on biomass feedstocks, industrial biotechnology and all kinds of bio-based materials. His work focuses on sustainability, market analysis, techno-economic and creating a suitable political and economic framework for bio-based processes and applications.

Wolfgang Baltus (PhD) (Thailand) worked for BASF for 15 years and was responsible for the business development of environmental friendly coatings in Asia. From 2008 until 2015, Baltus worked for the National Innovation Agency (NIA) and for Precise Corporation in Bangkok. In 2016, he founded his own independent consultancy, Wobalt Expedition Consultancy. He is regarded as one of the leading experts on bio-based polymer markets and policy in Asia.

Doris de Guzman (BSChE) (USA) joined UK-based Tecnon OrbiChem in March 2013 as a senior consultant covering bio-based chemicals feedstocks for the company's Bio-Materials Chemical Business Focus newsletter published every month. Doris has been covering the business of green chemistry for more than 16 years and provides expertise on oleochemicals, biofuels, biopolymers, industrial biotechnology and other renewable chemical products as creator and author of the Green Chemicals Blog. The blog has an average 15,000 to 20,000 unique readers per month.

Harald Käb (PhD) (Germany) is a chemist and has an unblemished 20-year "bio-based chemistry and plastics" track record. From 1999 to 2009 he chaired the board and developed "European Bioplastics", the association representing the bioplastics industry in Europe. Since 1998 he has been working as an independent consultant, servicing green pioneers and international brands to develop and implement smart business, media and policy strategies for bio-based chemicals and plastics.

Achim Raschka is working at nova-Institute since 2008, in 2013 he became head of the Department of Technology and Markets. He is involved in different national and international research programs concerning the material use of bio-based products and renewable resources, biotechnological and chemical-technical topics, bio-based monomers and sustainable feedstocks for Industrial Biotechnology as well as the CO_2 capture and utilization (CCU).

Jan Ravenstijn (MSc) (The Netherlands) has more than 35 years of experience in the chemical industry (Dow Chemical and DSM), including 15 years in executive global R&D positions in engineering plastics, thermosets and elastomers, based in Europe and in the USA. He is currently a consultant to producers, investors and consulting companies involved in bio-based monomer or polymer activities, member of the Scientific Advisory Board of the Aachen-Maastricht Biomaterials Institute and has published several papers and articles on the market development of bio-based monomers and polymers. He is regarded as one of the world's leading experts in his field.

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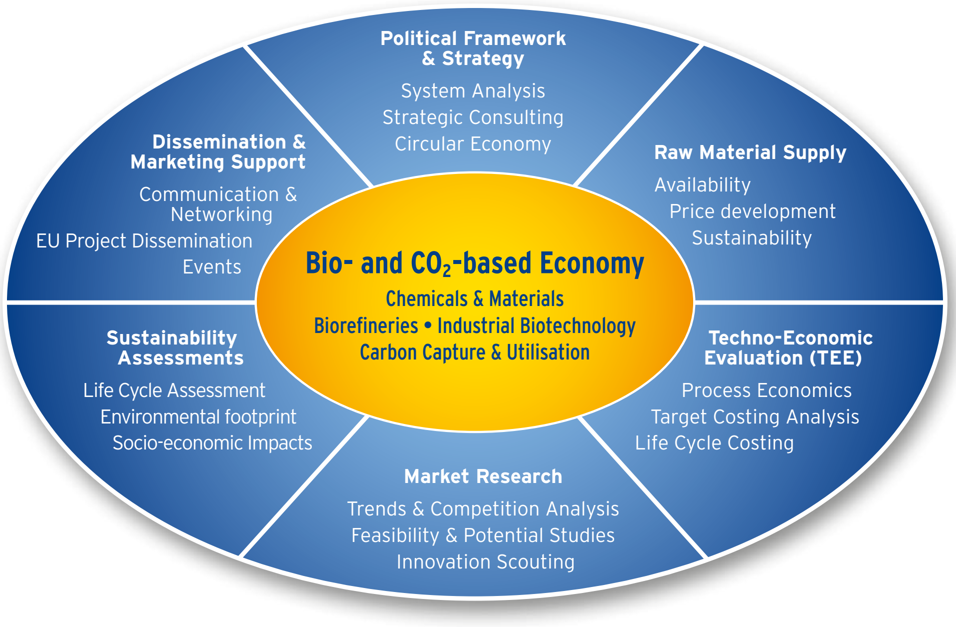

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nova-Institute is a private and independent research institute, founded in 1994; nova offers research and consultancy with a focus on bio-based and CO_2-based economy in the fields of feedstock, techno-economic evaluation, markets, sustainability, dissemination, B2B communication and policy. Every year nova organises several large conferences on these topics, nova has 30 employees and an annual turnover of about 3 million €.

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