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Institute for Bioplastics and Biocomposites

Welcome to a joint webinar of IfBB and thinkstep

Introducing the new Bio-Plastics LCA tool

We start in 2 minutes!

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Intro to GoTo Webinar

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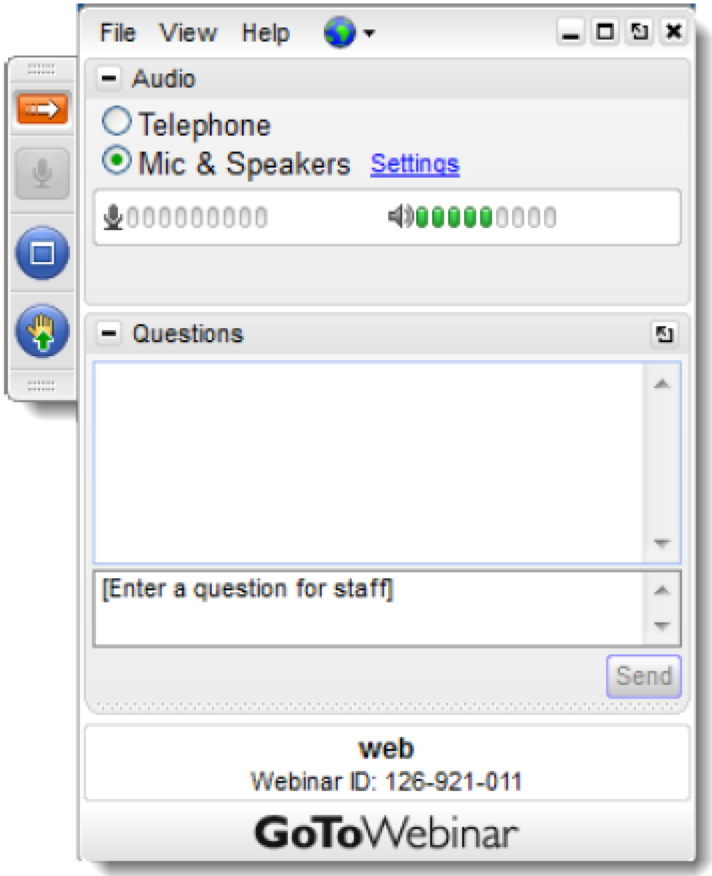
Audio options

Questions



Send

Institute for Bioplastics and Biocomposites

Issue from IfBB webinar series: „Biomaterials in focus!“
under the direction of Prof. Dr.-Ing. Hans-Josef Endres
and Dr. Andrea Siebert-Raths

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Martijn Gipmans

thinkstep AG

Christian Schulz

IfBB

Yannick Bernard

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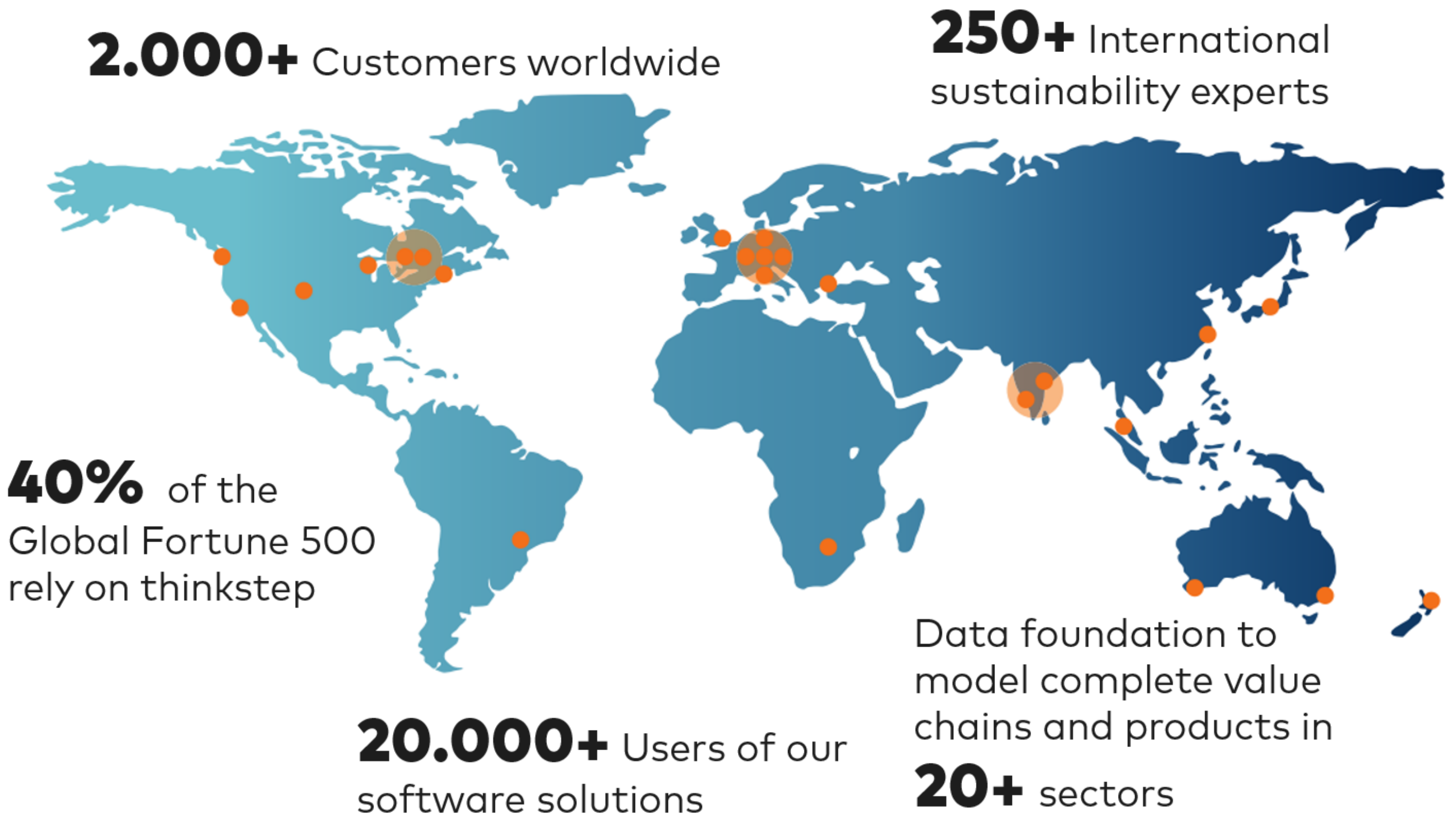
Sustainability consulting, software & data



thinkstep enables organizations worldwide to succeed sustainably. Our industry-leading software, data and consulting services help businesses drive operational excellence, product innovation, brand value and regulatory compliance. With a global presence in 19 countries we serve more than 2,000 companies, including 40 percent of the Fortune 500, such as BASF, Hewlett-Packard, Interface, Siemens, Unilever and Volkswagen.

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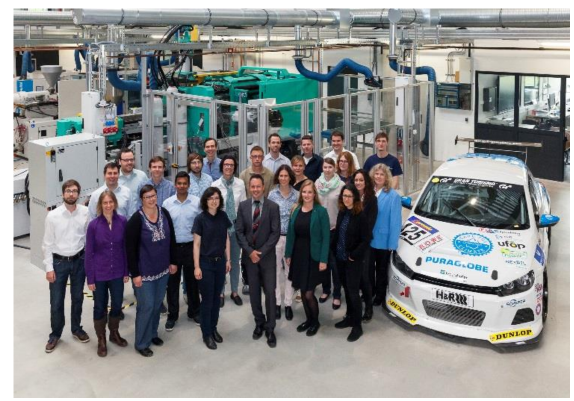
The IfBB at Hanover University of Applied Sciences and Arts

IfBB
Institute for Bioplastics and Biocomposites

- Established in 2011
  (following a steady increase in research activities)
- Institutional director: Prof. Dr.-Ing. Hans-Josef Endres
  (faculty member since 1999 at Hochschule Hannover)
- Employees: approx. 30
- Annual turnover: approx. 3 million €
- Close networking with industry
- Work priorities in the field of biomaterials:
  – Specific material development
  – Processing
  – Recycling and other end-of-life options
  – Sustainability evaluations
  – Provision of information
    (market development, databases)
- Close collaboration with Fraunhofer WKI's Application Center for Wood Fiber Research HOFZET

Quelle: Ksenia Kuleshova



Quelle: China Hopson

What are bioplastics?

- Not a novel material group, but part of plastics
- Bioplastics can be classified as:
  - Biodegradable petro-based biopolymers
  - Biodegradable (mainly) biobased biopolymers
  - Non-biodegradable, durable biobased biopolymers

- Advantages of bioplastics:
  - Renewable raw material base
  - Feedstock production for bioplastics requires less energy
  - Novel material properties
  - Manifold disposal possibilities (mechanical recycling, composting, climate-neutral energy recovery)

Generation comparison

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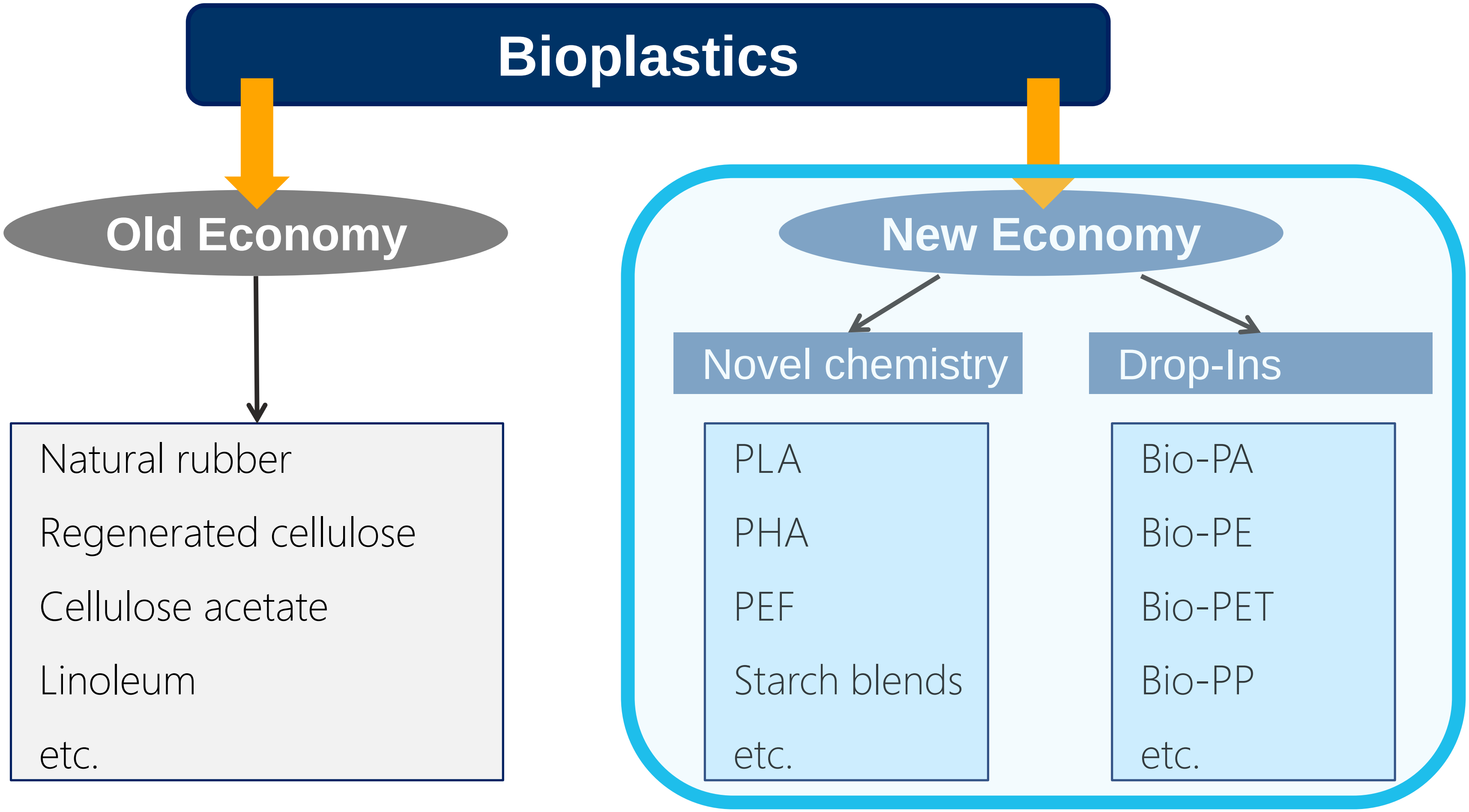

Old vs. New Economy – Production capacity

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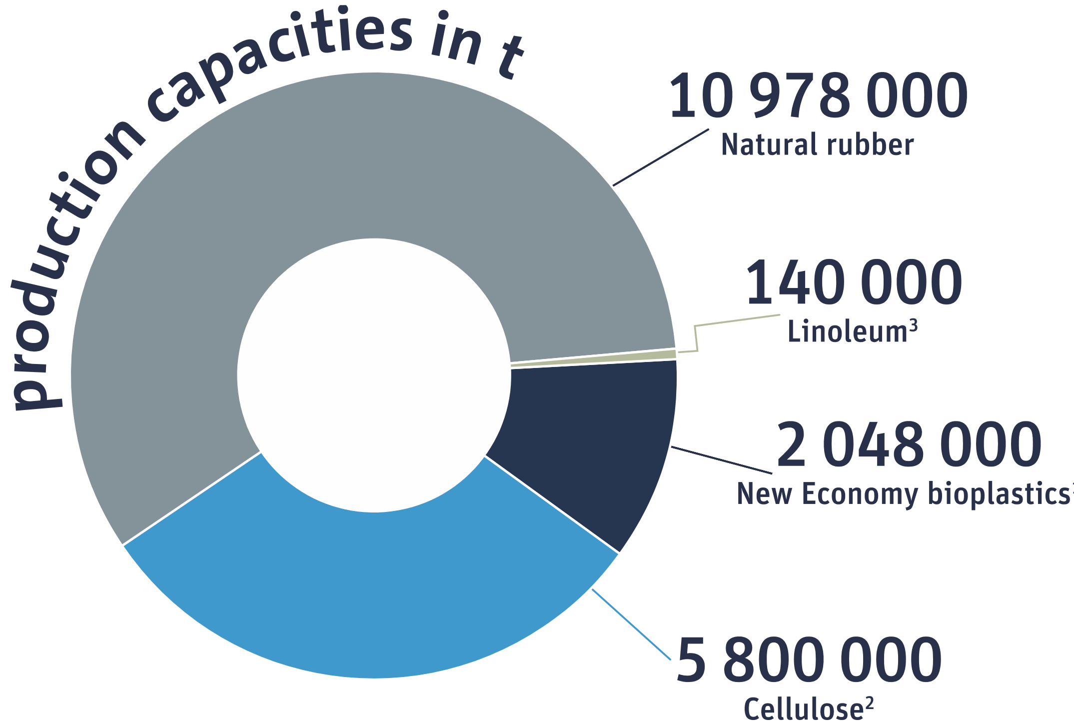

[1] PLA, PHA, PTT, PBAT, Starch blends, DropIns (BioPE, BioPET, BioPA) and other
[2] Material use excl. paper industry
[3] Calculations include linseed oil only

Market overview

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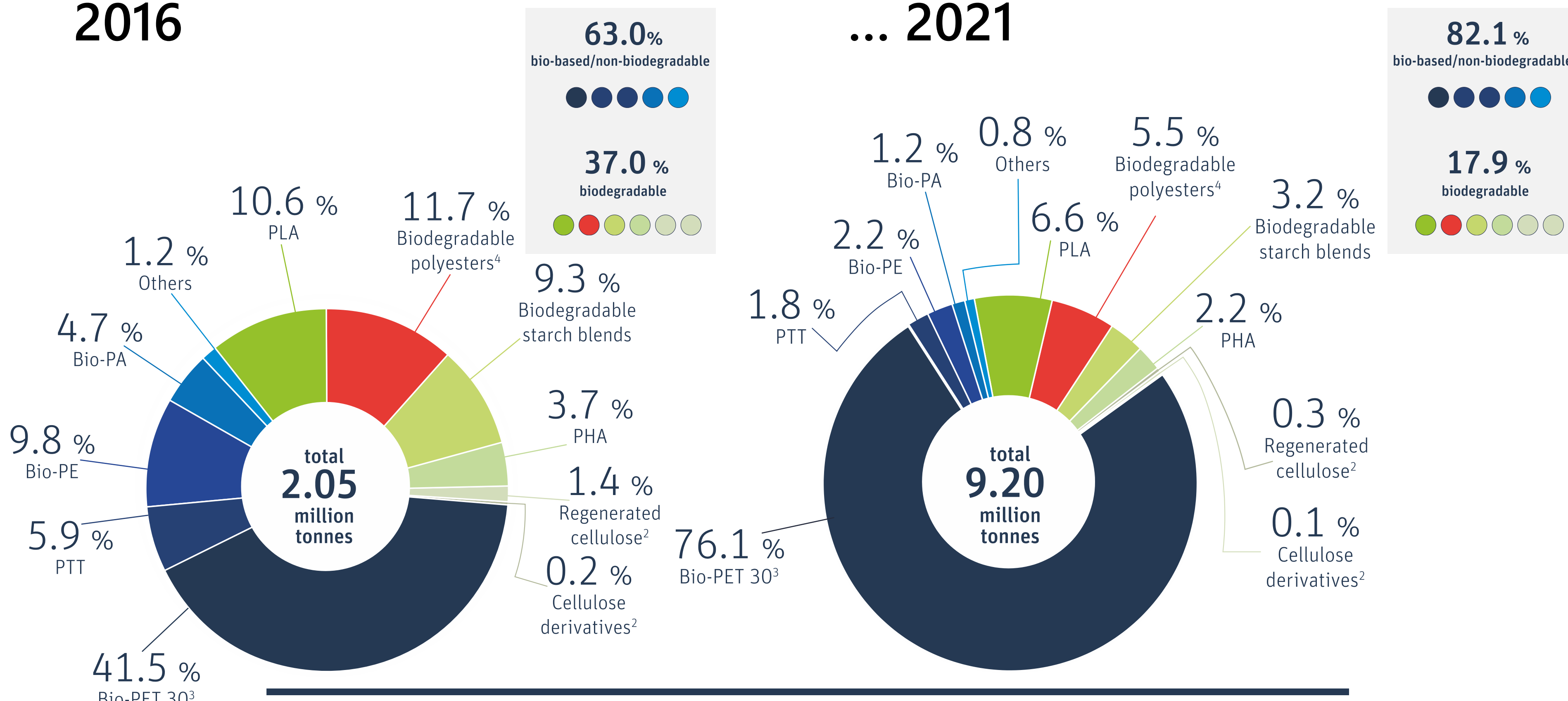
Bioplastics production capacity New Economy

2016 ... 2021



[1] Biodegradable cellulose esters [2] Compostable hydrated cellulose foils [3] Biobased content amounts 30% [4] Contains PBAT, PBS, PCL

Trends: Geographical shift of production capacities

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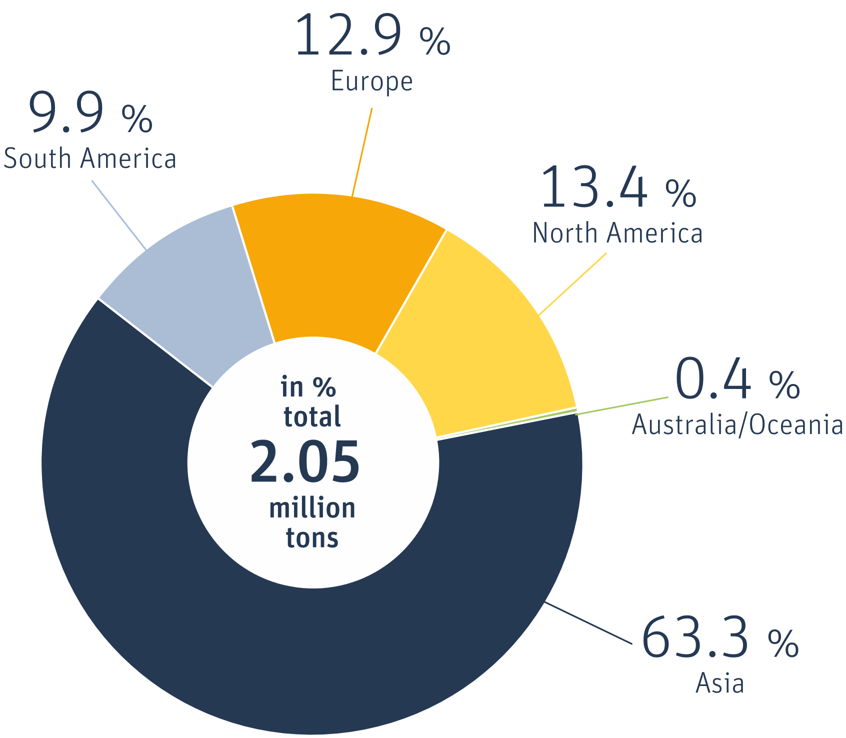
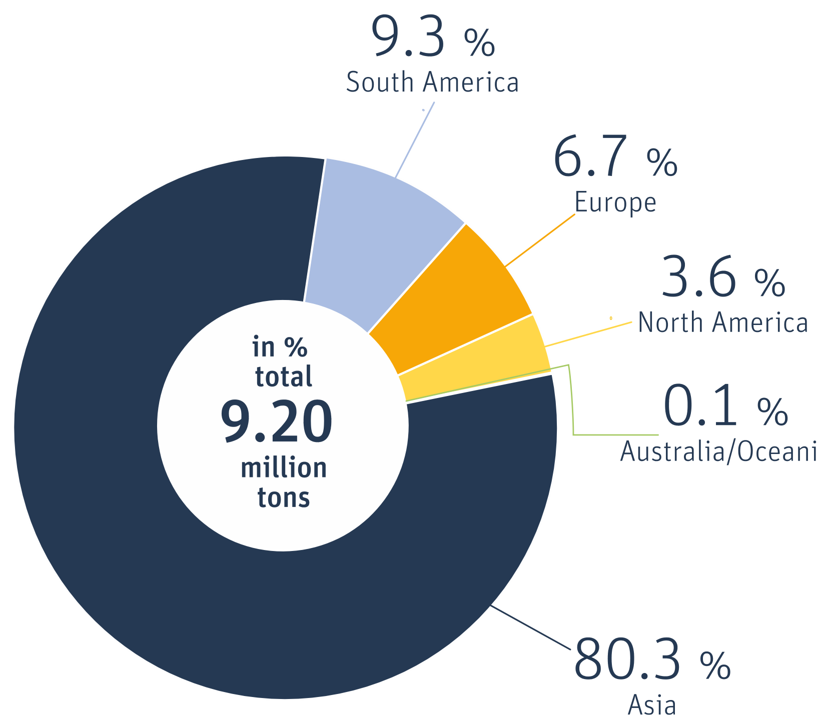
Bioplastics production capacity New Economy

2016

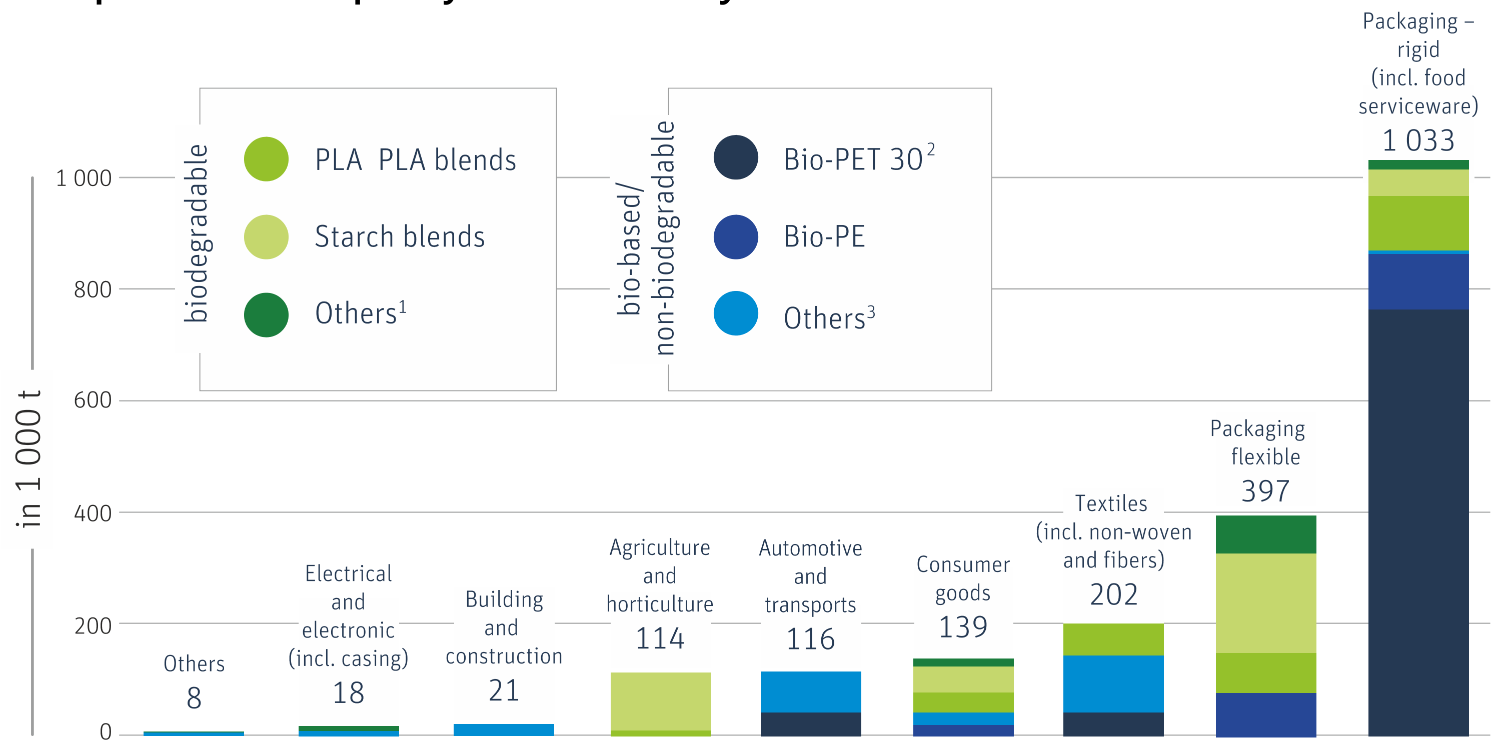


… 2021



Trends: Market segments

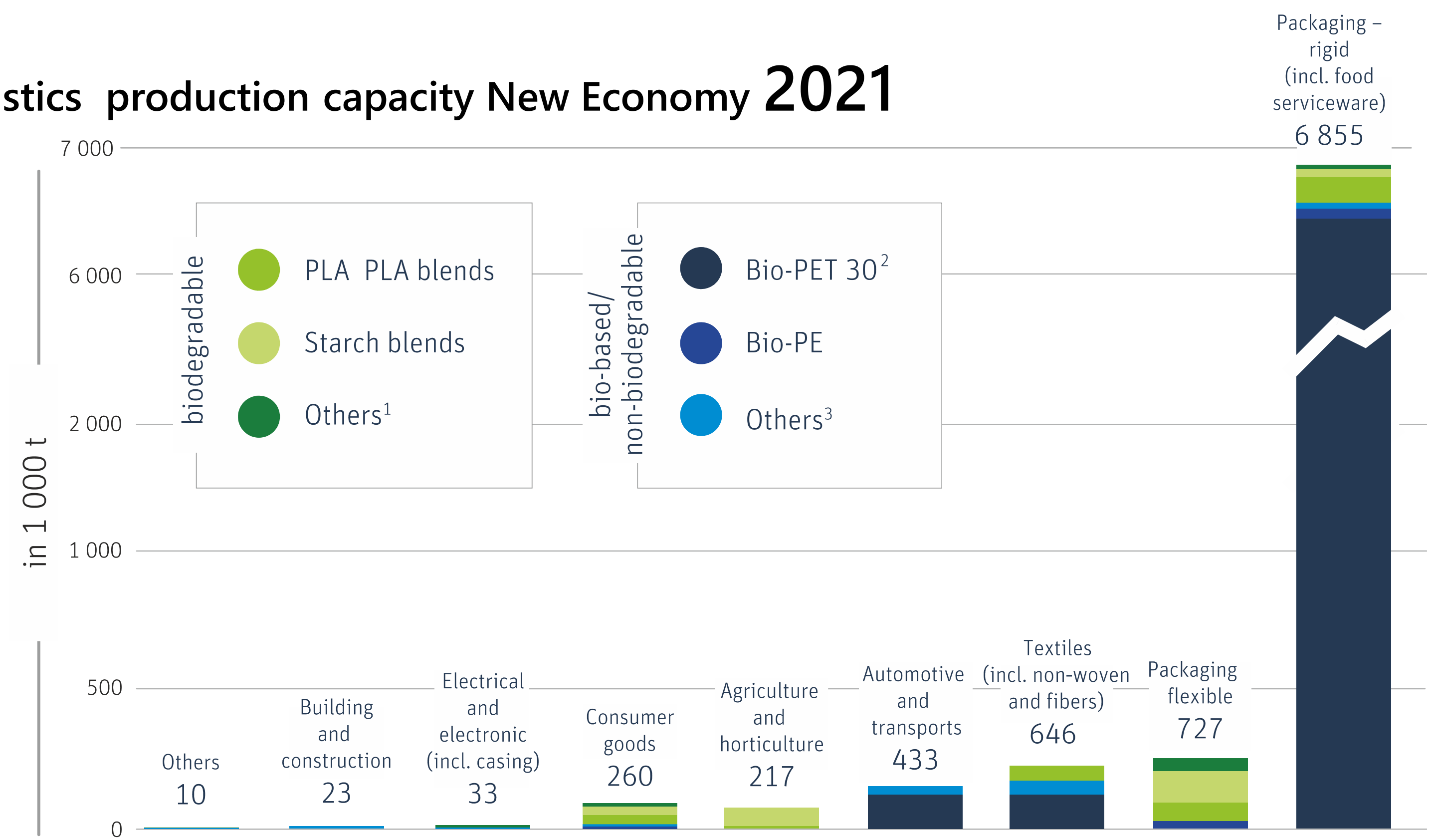
Bioplastics production capacity New Economy 2016



[1] Contains regenerated cellulose and biodegradable cellulose ester
[2] Biobased content amounts to 30%
[3] Contains durable starch blends, BioPC, BioTPE, BioPUR (except thermosets), BioPA, PTT

Trends: Market segments

Bioplastics production capacity New Economy 2021



[1] Contains regenerated cellulose and biodegradable cellulose ester
[2] Biobased content amounts to 30%
[3] Contains durable starch blends, BioPC, BioTPE, BioPUR (except thermosets), BioPA, PTT

Challenges

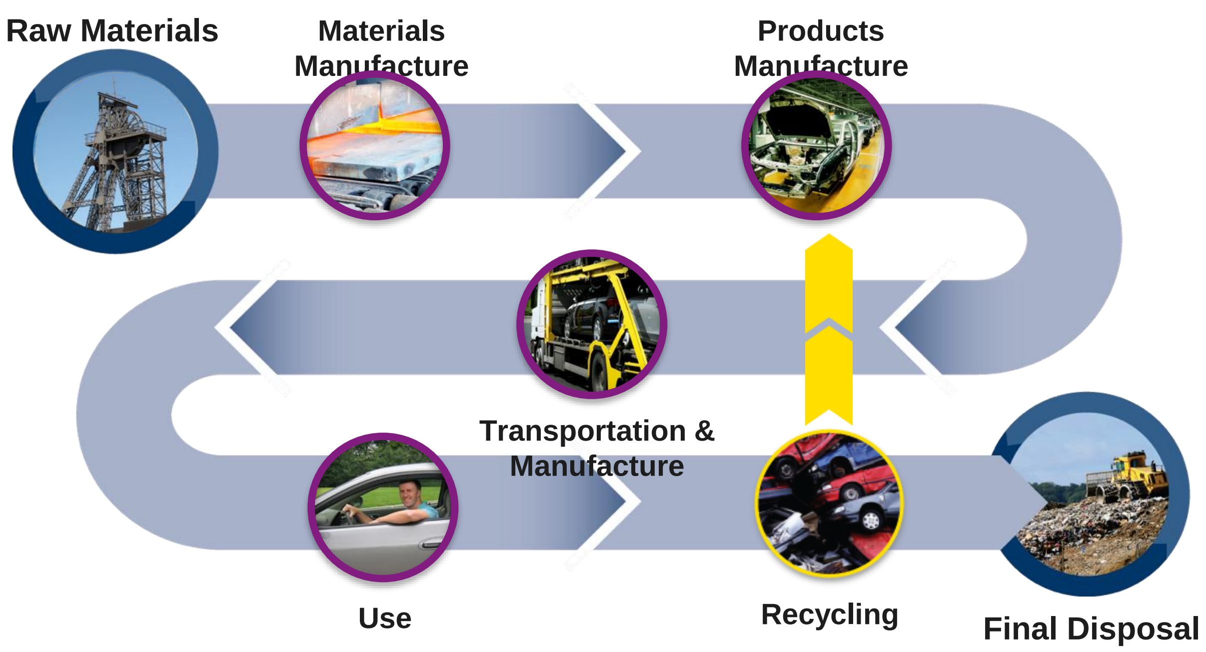
- Environmental benefits of bioplastics in comparison to conventional plastics are one of the key drivers for their use and promotion.
- Companies who intend to use bioplastics for their products are in the demand to quantify and proof the environmental benefits to avoid false claims and greenwashing.
- Especially small and medium sized enterprises are confronted with the challenge to generate these information in an effective, high quality and low cost way.

Life Cycle Thinking: seeing the bigger picture

Life-Cycle thinking ensures that all aspects of a product life cycle are considered to generate an optimum solution without shifting of problems or burdens.

Life-Cycle Assessment (LCA) is a structured tool for assessing environmental burdens across the whole product life cycle, either to identify improvement areas or to make comparisons with other product or service systems.

LCA is used in decision making as a tool to improve product design, for example the choice of materials, the selection of technologies, specific design criteria and when considering recycling.



GaBi – the leading Life-Cycle Assessment software and database combination

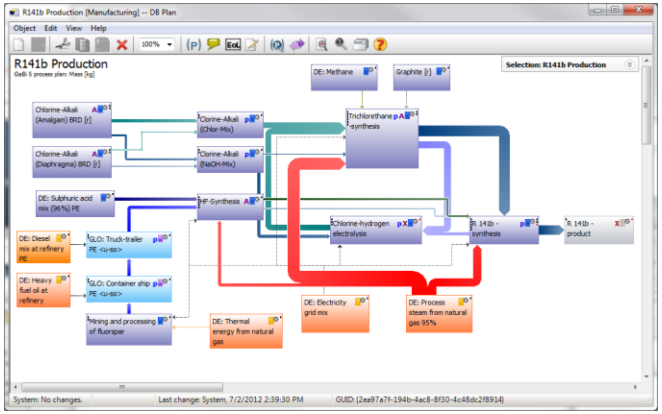
thinkstep GaBi

Software

GaBi software is a **modelling, reporting & diagnostic tool** that drives product sustainability performance during design, planning and production.

GaBi software comes with **comprehensive LCA functionality** and **database content** for any product and process sustainability question

GaBi software provides access to the new LCA hub – a web-based tool for easy **LCI data collection**



Database

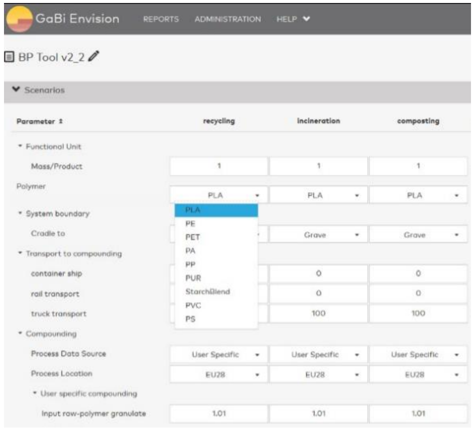
GaBi database contains **more than 14,000 inventories** from 20+ industrial sectors available to customers and more than 60,000 **proprietary inventories** available to thinkstep consultants.

GaBi database enables **access to 3th party datasets** such as ecoinvent, US LCID and European Commission LCA data (PEF)

GaBi database is build on **15+ years experience** from 250+ thinkstep experts and **based on industry data** from more than 25 material associations & hundreds of EPDs.

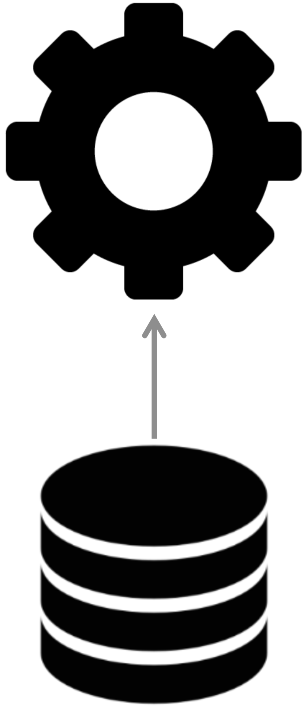
GaBi Envision Web for Bio-Plastics LCA tool

thinkstep GaBi



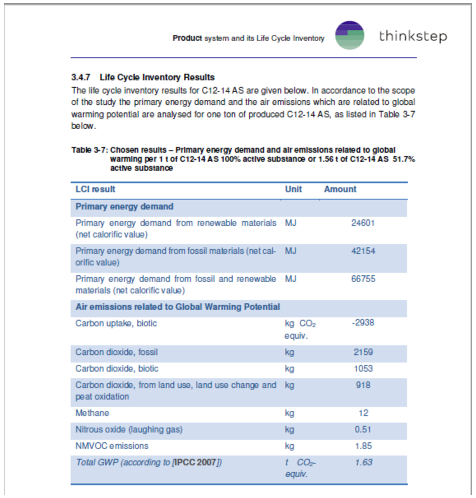
- Manual entry of parameter values
- Comparison of alternatives
- **Company-specific solution**
- **Shared platform with confidential access area for each company**

LCA Engine (GaBi)



Bio-Plastics models

Feedstock, granulates, additives conversions, transport, use, End-of-Life



Product system and its Life Cycle Inventory thinkstep

3.4.7 Life Cycle Inventory Results

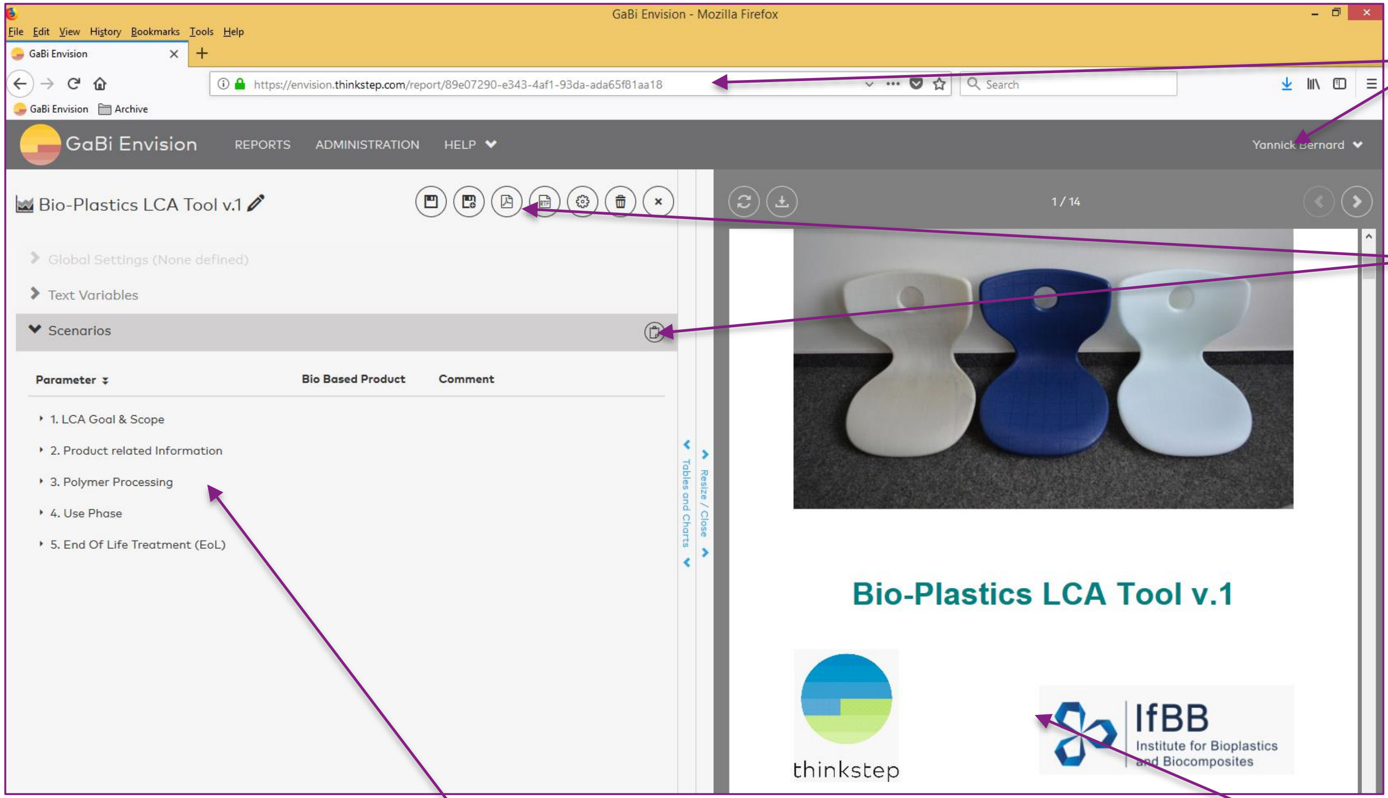
The life cycle inventory results for C12-14 AS are given below. In accordance to the scope of the study the primary energy demand and the air emissions which are related to global warming potential are analysed for one ton of produced C12-14 AS, as listed in Table 3-7 below.

Table 3-7: Chosen results – Primary energy demand and air emissions related to global warming per 1 t of C12-14 AS 100% active substance or 1.56 t of C12-14 AS 51.7% active substance

LCI result	Unit	Amount
Primary energy demand		
Primary energy demand from renewable materials (net calorific value)	MJ	24601
Primary energy demand from fossil materials (net calorific value)	MJ	42154
Primary energy demand from fossil and renewable materials (net calorific value)	MJ	66755
Air emissions related to Global Warming Potential		
Carbon uptake, biotic	kg CO_2 equiv.	-2938
Carbon dioxide, fossil	kg	2159
Carbon dioxide, biotic	kg	1053
Carbon dioxide, from land use, land use change and peat oxidation	kg	918
Methane	kg	12
Nitrous oxide (laughing gas)	kg	0.51
NMVOC emissions	kg	1.85
Total GWP (according to [IPCC 2007])	*t CO_2-equiv.*	*1.63*

- **Fully customizable report** (pdf)
- Set-up as datasheet possible
- Automatic calculation of results
- Result display as graphs and/or tables
- Background information
- Company logo

Main Window



Web-based tool with personal user login

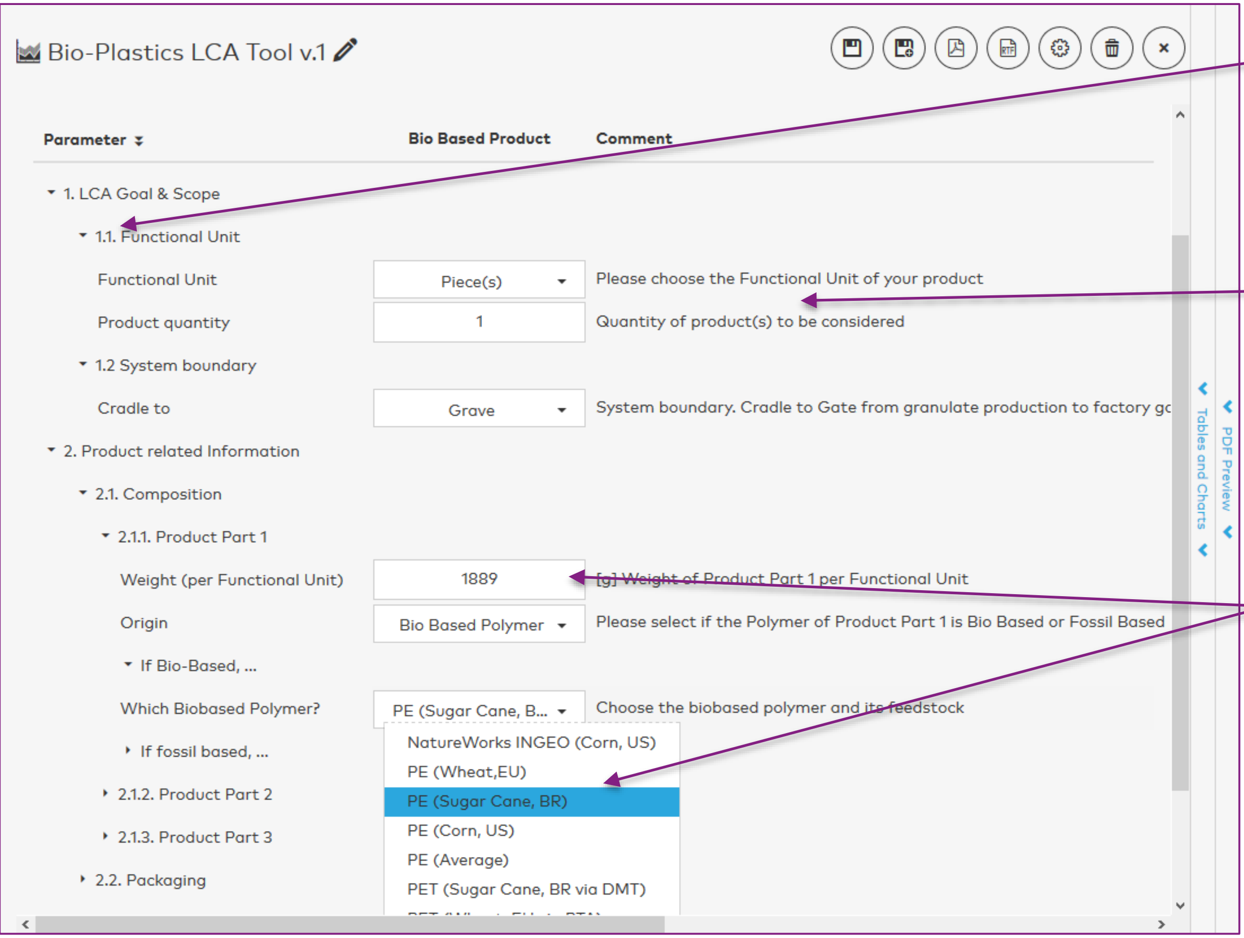
Export options of results and parameters to pdf, word and clipboard (-> excel)

Pre-structured parameter entry section reflecting on a defined base scenario (e.g. bio based product to be analyzed):

- Based on ISO 14040/44
- Following the value chain of Bio-Plastics

Company specific layout and content of report

Use of parameters



Topic related parameter organization to be unfolded

Comments on each parameter explain and help the user to understand what information to be given (e.g. parameter units)

Parameter entry either by typing of values or selection from pre-defined alternatives

LCA scope definition

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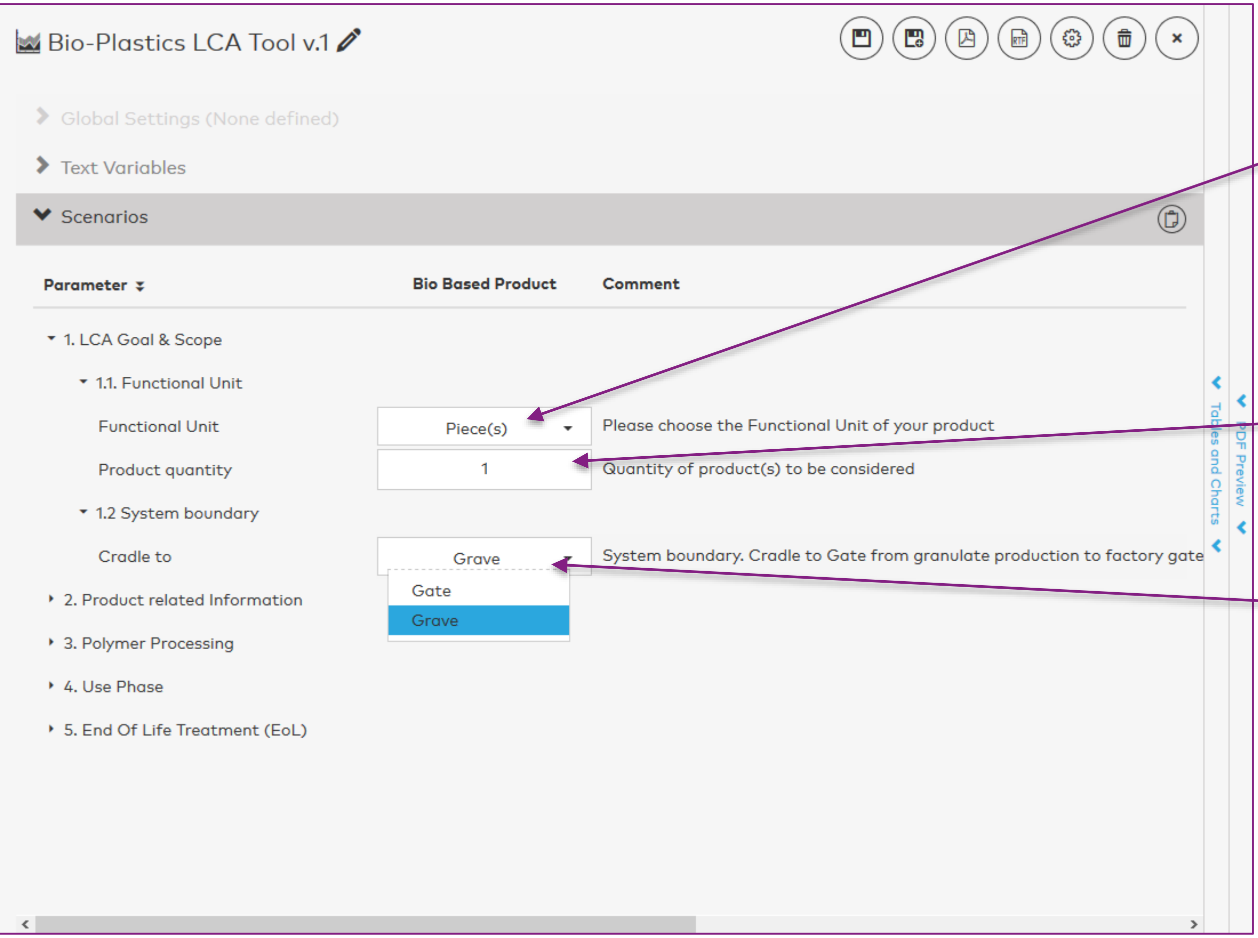


Define functional unit of the product to be assessed:

- Pieces
- Squaremeter
- Cubic Meter
- Kilogramm

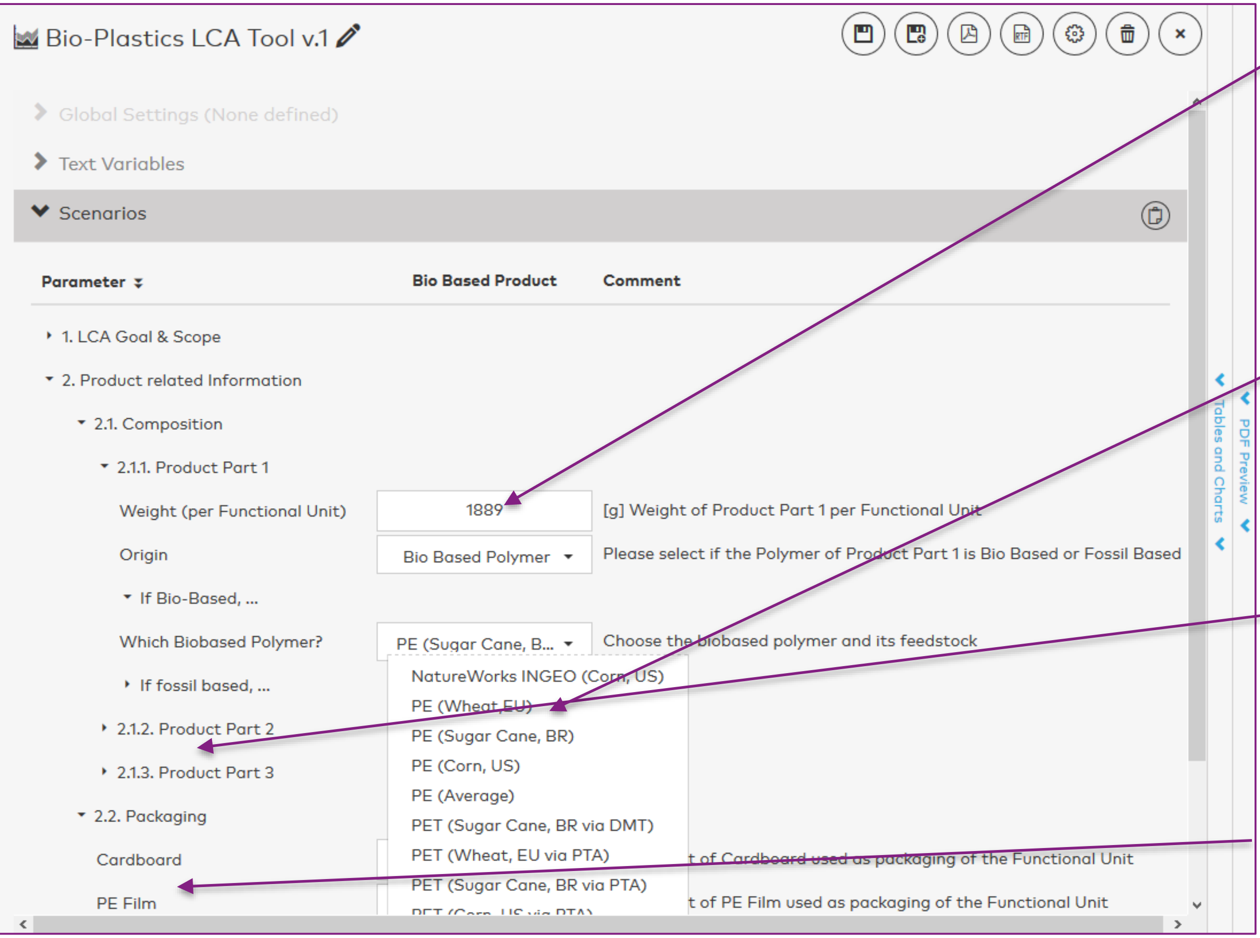
Enter amount of functional unit to be calculated

Select the system boundaries:

- Cradle-to-Gate
- Cradle-to-Grave

Product definition

thinkstep



Enter the weight (of part 1) of your product.

Select the raw polymer of your product (part 1)

Repeat for product parts 2 + 3 (if applicable to your case)

Choose packaging material for the defined functional unit, if desired

Specifiying production processes

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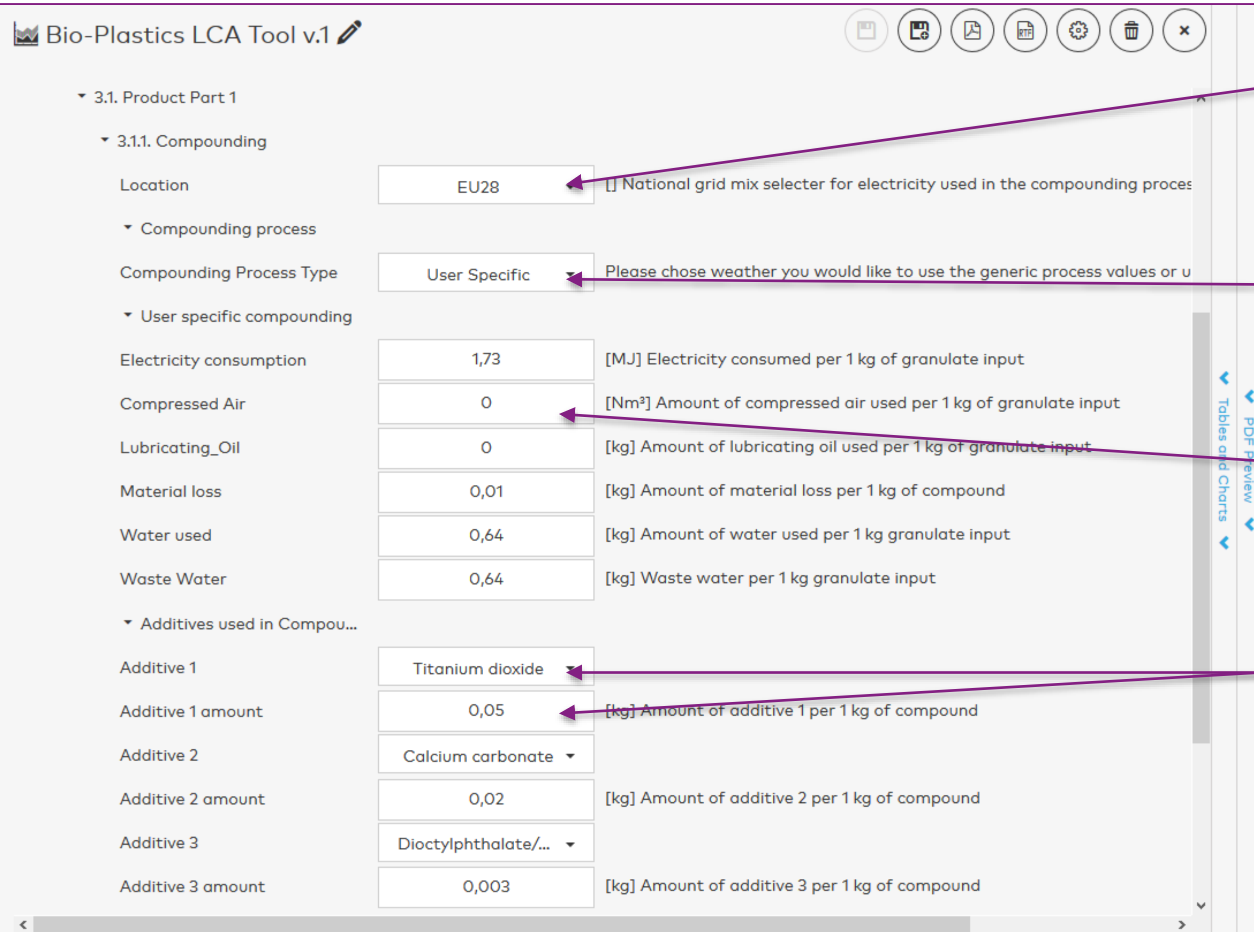


Define location of the granulate compounding -> electricity grid mix

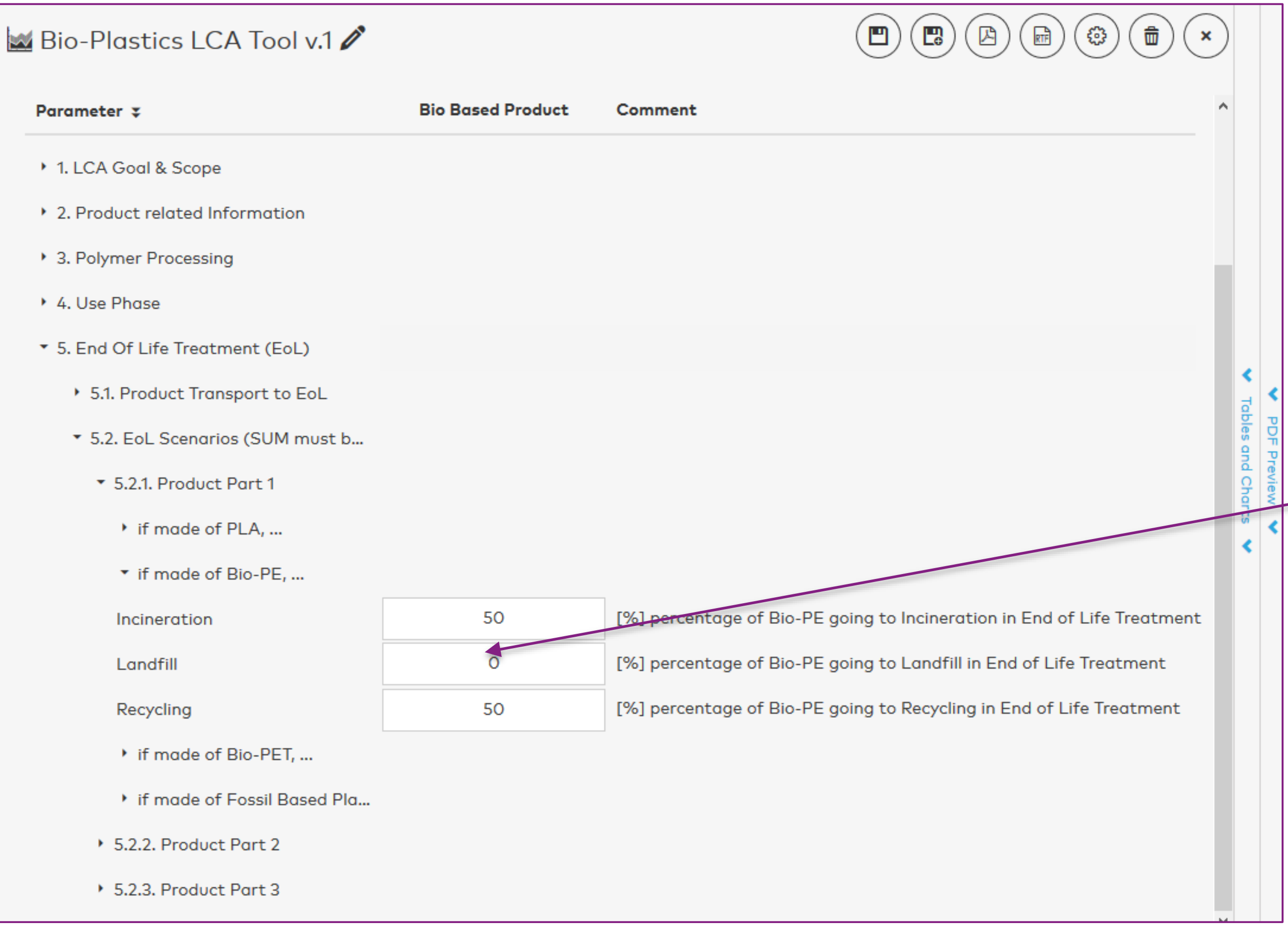
Choose if GaBi compounding process shall be used or if you wish to enter you own process data

Entry of manufacturer specific compounding process data

Define type and amount of additives used in compounding

End-of-Life treatment

thinkstep



Define the share of plastic specific End-Of-Life treatment scenarios

Ready for results calculation

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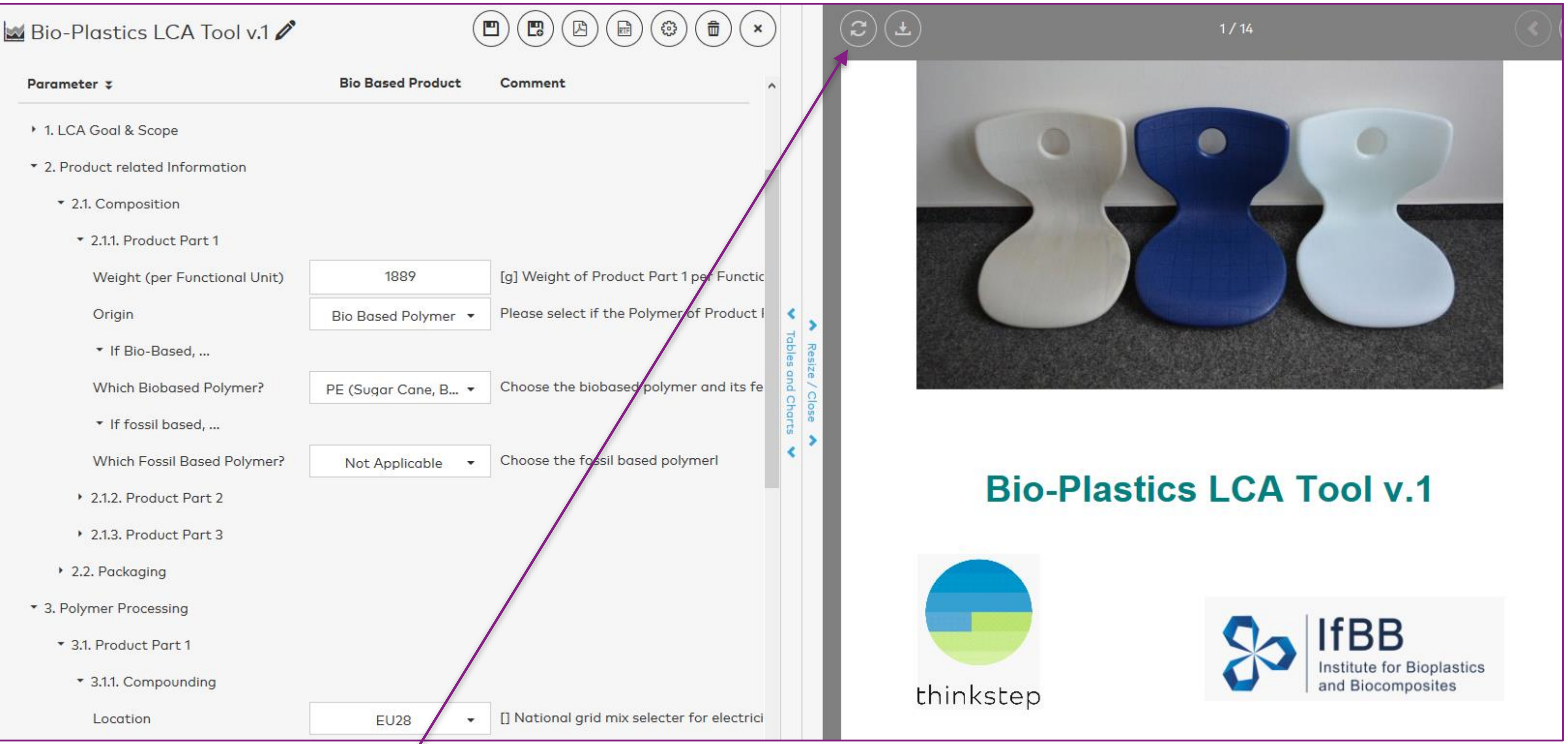

All parameter entries/changes affect the LCA results. (Re-)Calculation is started manually

Reporting Option: ISO 14040/44 compliant report

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2. System Description

This goal of this study is to calculate LCA results for the defined product of 1 Piece(s) of Example Product

First step to do so is calculating the related Life Cycle Inventory (LCI)

Please see the table 2-1 for an executive summary of the most relevant information on the product under study:

Table 2-1: Mass balance product

Information	per Product (as defined in Goal&Scope Section)
Product Related	
Part 1	
Weight Plastic [kg]	1.75
Weight Additives/Composite Materials [kg]	0.138
Weight Product Part 1 [kg]	1.89
Part 2	N.A.
Weight Plastic [kg]	
Weight Additives/Composite Materials [kg]	
Weight Product Part 2 [kg]	
Part 3	N.A.
Weight Plastic [kg]	
Weight Additives/Composite Materials [kg]	
Weight Product Part 2 [kg]	
Packaging	0
Product Weight (total) [kg]	**1.89**

The following table 2-2 shows the amount of post-consumer plastic waste per product for each assumed end-of-life treatment option which has been defined for each single product part independently.

Table 2-2: End-of-life treatment of polymers (excl. additives) in the study

	End of Life Polymers Product Part 1	End of Life Polymers Product Part 2	End of Life Polymers Product Part 3
Plastics incinerated [kg]	0.88		
Plastics composted [kg]			
Plastics put on landfill [kg]			
Plastics recycled [kg]	0.88		

Further information with influence on the LCI of the FU defined, especially regarding materials chosen for the products, process related information (energy, water, waste, etc.) can be taken from the following overview (table 2-3) on all parameter settings of the GaBi LCA model calculated in the background of this report:

Table 2-3: Parameter settings for underlying background GaBi LCA model

2. System Description

Scenario parameters		
	Bio Based Product	
1. LCA Goal & Scope		
1.1. Functional Unit		
Functional Unit	Piece(s)	Please choose the Functional Unit of your product
Product quantity	1	Quantity of product(s) to be considered
1.2 System boundary		
Cradle to	Grave	System boundary. Cradle to Gate from granulate production to factory gate of finished product; Cradle to grave: from granulate production to end of life of product
2. Product related Information		
2.1. Composition		
2.1.1. Product Part 1		
Weight (per Functional Unit)	1889	[g] Weight of Product Part 1 per Functional Unit
Origin	Bio Based Polymer	Please select if the Polymer of Product Part 1 is Bio Based or Fossil Based
If Bio-Based, ...		
Which Biobased Polymer?	PE (Sugar Cane, BR)	Choose the biobased polymer and its feedstock
If fossil based, ...		
Which Fossil Based Polymer?	Not Applicable	Choose the fossil based polymerl
2.1.2. Product Part 2		
2.1.3. Product Part 3		
2.2. Packaging		
Cardboard	0	[kg] Weight of Cardboard used as packaging of the Functional Unit
PE Film	0	[kg] Weight of PE Film used as packaging of the Functional Unit
3. Polymer Processing		
3.1. Product Part 1		
3.1.1. Compounding		
Location	EU28	[] National grid mix selecter for electricity used in the compounding process
Compounding process		
Compounding Process Type	User Specific	Please chose weather you would like to use the generic process values or use your own input values
User specific compounding		
Electricity consumption	1.73	[MJ] Electricity consumed per 1 kg of granulate input

Customizable text and tables: e.g. mass balance of product in scope

Automatic read out of all defined background parameters

Screenshots of GaBi background model can be included as well

Reporting Option: LCA Fact sheets

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Automatic read out of LCA results based on parameter entries

Visualization in customizable diagrams

Further diagrams for e.g. results interpretation already integrated

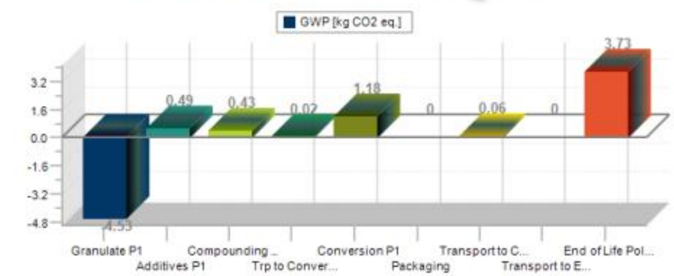
3. Life Cycle Inventory and Impact Assessment

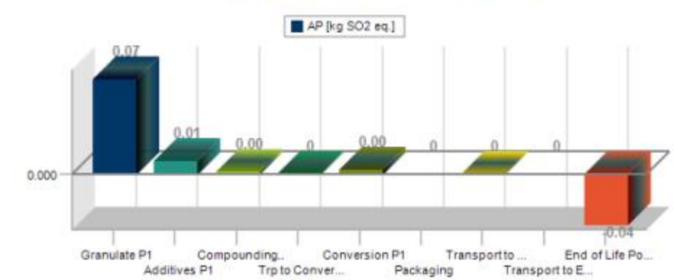
Tabelle 3-1: LCIA results per 1 Piece(s) of Example Product

Impact Indicator	Unit	Cradle -to- Gate	Cradle -to- Grave	Category
GWP *	[kg CO_2 eq]	-2.41	1.38	Global Warming
AP	[kg SO_2 eq]	0.08	0.045	Acidification
EP	[kg PO_4 eq]	0.0583	0.0304	Eutrophication
PERT	[MJ]	230	117	Primary Energy fr.Renewables
PENRT	[MJ]	21.4	2.69	Primary Energy fr.Non Renewables
Blue Water Consumption	[kg]	1.61	4.94	Water

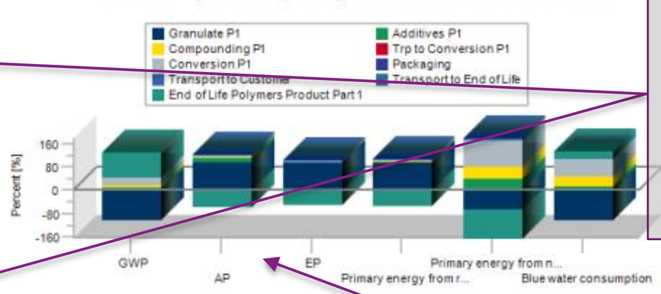
The carbon footprint result (GWP) is: **1.38 kg CO_2 eq.**

* This result includes (!) biogenic Carbon Dioxide (and Methane). Communication of the Cradle-to-Gate result should always additionally inform about the GWP of the End-Of-Life Treatment.



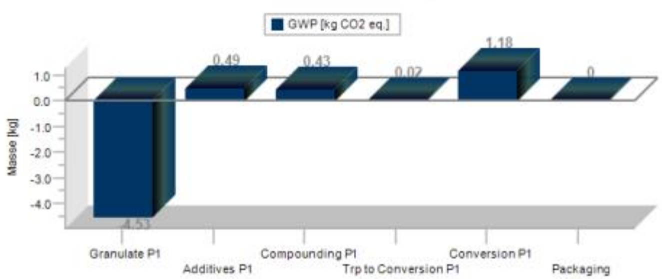


4. Interpretation



For interpretation of dominant life cycle stages as shwon in the figure above please consider the assumptions and parameter settings of chapter 2.

The following figures show the GWP results just for the cradle-to-gate stage respectively End-Of-Life treatment:



Scenario Analysis

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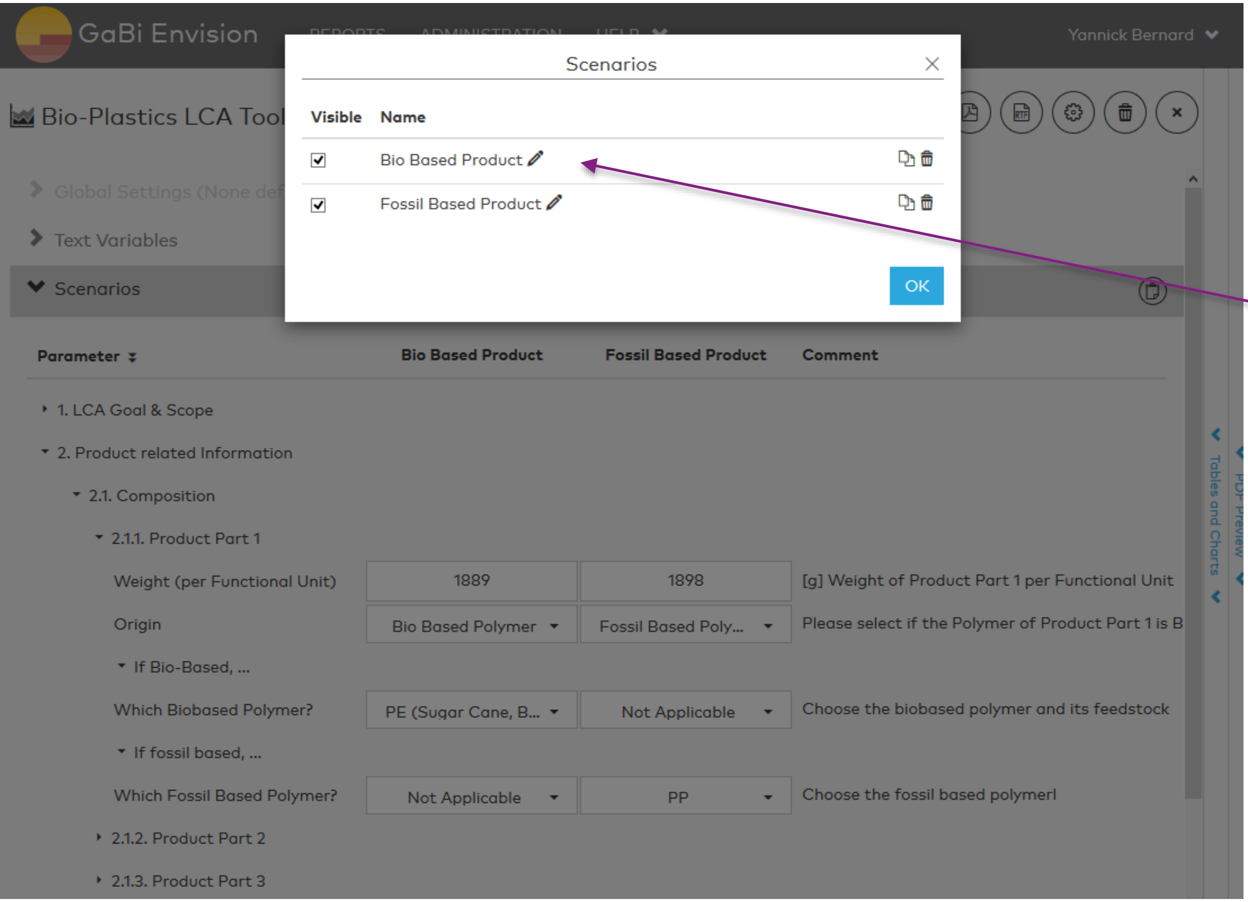

Freely create alternative scenarios which can be compared with the previously defined base scenario:

- Alternative materials / additives
- Reduced product weight
- More efficient production process(es) – less energy, less waste
- Alternative transport routes/vehicles
- Different EoL-Options

Scenario Analysis – results view

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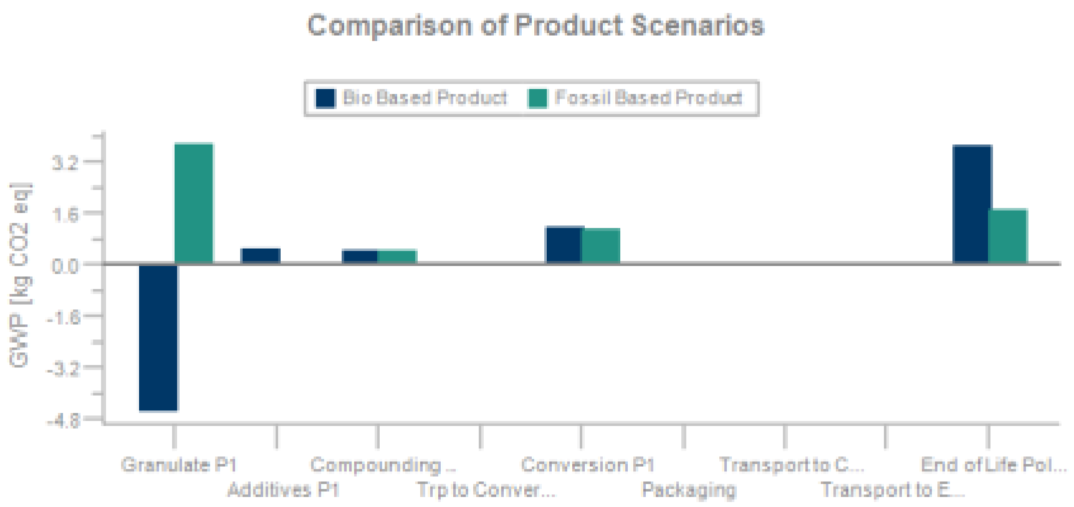
5. Scenario Analysis

Tabelle 5-1: Comparative LCIA results scenarios considered

	Bio Based Product	Fossil Based Product
GWP [kg CO2 eq.]	1.38	7.09
AP [kg SO2 eq.]	0.04	0.01
EP [kg Phosphate eq.]	0.03	0.00
Primary energy from renewable resources (net cal. value) [MJ]	116.63	4.63
Primary energy from non renewable resources (net cal. value) [MJ]	2.69	142.81
Blue water consumption [kg]	4.94	28.19

Derive decisions from the scenario comparison, potential trade offs are shown in a transparent way



Open for company specific customization

- Addition of further datasets – either from GaBi but also based on primary data delivered by owner of the LCA tool:
  - (bio)-plastic granulates (and all included steps: feedstock, fermentation, polymerization)
  - additives / composite materials
  - compounding / conversion processes
  - EoL-treatment options

- Addition of further auxiliaries, grid mixes, etc.

- Adaptation of scope / parameter section to company (department) specific needs

- Adaptation of reporting to company (department) specific needs:
  - full verifiable ISO 14040/44 report vs.
  - screening quick check GWP fact sheet vs.
  - company specific evaluation methods (e.g. conversion of GWP expressed in kg CO_2 eq into km of driving a car)

Your benefits using the Bio-Plastics LCA tool

thinkstep

✓ Bio-Plastic specific GaBi database (incl. feedstocks, granulates, additives, conversions, auxiliaries, transport, end-of-life)

✓ IfBB as scientific development partner for LCA data

➡ **Base your decisions on consistent, high quality, up-to-date and reliable background data**

✓ Comparison of scenarios (products, conversion/compounding processes, transport options, end-of-life (recycling, composting, incineration), bio-plastics vs. conventional plastics)

➡ **Know about the environmental consequences before investing in product and process changes**

✓ Easy-to-use interface, instant result calculation and reporting with customized content, tables, diagrams, format and company design

➡ **Communicate verifiable LCA results created by your own without being a LCA expert**

✓ The tool covers all stages of the bio-plastics supply chain

➡ **Being prepared to answer questions from your clients and even questions asked to your clients** thinkstep

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Thank you.

For more information, please contact:

yannick.bernard@thinkstep.com
martijn.gipmans@thinkstep .com

Or visit our website: https://info.thinkstep.com/bioplastic