



RoadToBio

Roadmap for the chemical industry towards a bioeconomy

Duration time: 24 Month; May 2017 – April 2019

Budget: 996.000 €

Consortium:



**Bio-based sweet spots for the chemical industry – A conclusion
and discussion after the second stakeholder workshop**
11 July 2018

Lea König (DECHEMA), Mladen Crnomarkovic (E4tech)

Agenda of the webinar

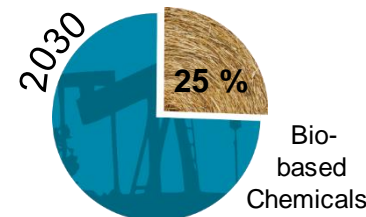
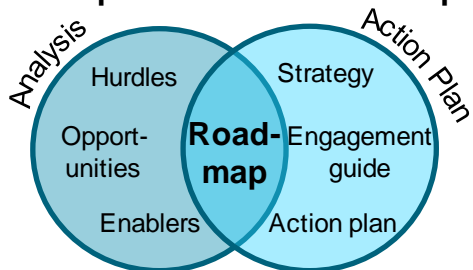


- Welcome and Introduction of the project
 - Introduction of the business cases
 - Conclusion of the workshop
- Workshop results: Focus on polymer-based dedicated chemicals
 - Lactic acid
 - PHA
 - PEF
 - Barriers to increase the bio-based share of chemical products in the EU
 - Outlook: Implementation of the results in the Roadmap
- Q & A session

RoadToBio: The road into a bio-based future



Components of the roadmap

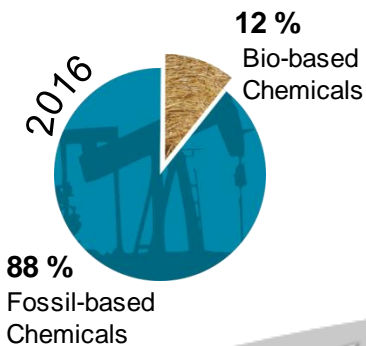


Stakeholder participation in creating the roadmap:

- Chemical Industry
- NGOs
- Administrative Bodies
- Governments

Key challenge

How can the European chemical industry remain competitive and at the same time become more sustainable?



Business case of RoadToBio



Aim

- Attractive **opportunity for the chemical industry** to enlarge the bio-based portfolio
- From 9 business cases **key learnings** about actions needed to overcome barriers and realise business cases

What do the business cases show?

- Addressed societal needs
- Product markets
- Actors and their potential benefits as well as for the society
- Technical and commercial barriers
- Conditions of the value chains to provide viable business cases

How do they fit into the roadmap?

- Combine the various studies and use specific examples to show
- How the bio-based share of the production portfolio can be increased
 - Advantages exist for the respective producer

Roadmap content and learnings



From 9 business cases key learnings about actions needed to overcome barriers and realise business cases



Roadmap

Key actors

Identified key actors involved in achieving 25% by 2030 goal.

Barriers

Summarised key barriers specific to industry sector or business case. Characterisation of barriers in terms of time horizon impact (e.g. immediate/mid/long-term), impact on different actors, opportunity to overcome them, etc.

Action plan

List of actions, applicable to wider sector, which need to be taken in order to achieve the goal of 25% by 2030. Identified time-scale of each action and actor who will carryout these activities.

Benefits

Benefits from the level of deployment assessed in terms of: market uptake/shares, GHG reduction, job creation

Structure of the business cases



Value chain summary

- Value chain description for bio-based chemical and its fossil counterpart
- Feedstock type
- Key derivatives and applications (sectors)
- Customers/consumers

Supply

- EU Industry structure & integration
- Key players (producers/developers)
- Competing technologies (bio-based and fossil) – key characteristics and development status
- Production costs (bio-based & fossil)

Market analysis

Demand

- Market characteristics (volume, growth, prices)
- Market drivers & trends (economic, societal, policy, etc.)
- Sustainability requirements for downstream application (or per sector)

Opportunities

- From commercial businesses stand point (EU's industry and SMEs)
- Conditions under which value chains provide valuable business proposition (techno-economic assessment)

Success factors

- Investments requirements
- Regulatory framework
- Compatibility with existing value chains (up and downstream integration, feedstock availability)
- Skills, competences, infrastructure

Barriers

- Commercial (product prices)
- Technical (technology development, feedstock availability, product performance)
- Political
- Standard/labelling

Benefits

- From the standpoint of EU as a whole
- Societal (job creation)
- Economic (export, growth)
- Environmental (GHG and waste reduction)
- Resource resilience (imports dependency, circular economy)

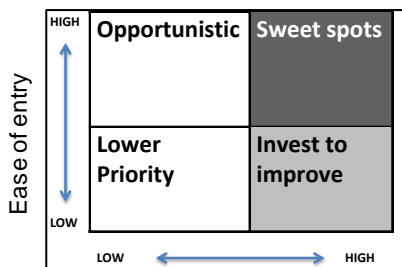
Methodology of business case selection

Identification of the sweet spots

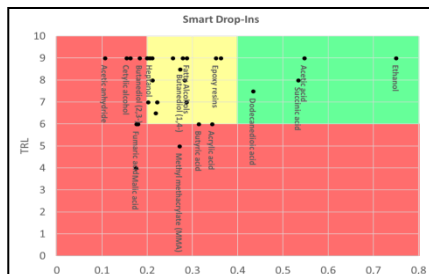
Analysis of the bio-based opportunities for the chemical industry



Ranking for 'market potential' and 'ease of implementation'



Creating and ranking long list
For each kind of chemical group
→ **Sweet spots**



Priorities of the chemical industry for selection of business cases

Criteria
Improvement in resource efficiency
Bio-based product has improved functionality
High margin can be obtained
Low risk for political or ethical disputes
Savings in GHG emissions
Availability of biomass in the EU
Decrease in use of toxic /harmful substances
Potential for green premium
EU has competitive advantages



Workshop 02.07.17
Phone interviews



Product group	Feedstock	Sugar/Starch	Vegetable oil	Rest streams/other
Platform chemical	Lactic acid	Ethylene	Furfural	
	1,4-Butanediol	Glycerol	Methanol	
Solvent				
Adhesive				
Agrochemical				
Lubricant				
Plastic	PEF			PHA
Man-made fiber				
Coatings		Dodecanedioic Acid		
Surfactant				

Dedicated, Drop-in, Smart drop-in

9 business cases



Workshop 19.06.18



Bio-based chemical groups of RoadToBio



Group	Drop-In chemicals	Smart Drop-In chemicals	Dedicated chemicals
Definition	<ul style="list-style-type: none"> Chemically identical to fossil based chemicals 	<ul style="list-style-type: none"> Subgroup of drop-ins Bio-based pathway provide advantages 	<ul style="list-style-type: none"> Dedicated production pathway No identical fossil-based chemical
Advantage	<ul style="list-style-type: none"> High volume No additional production costs for chemical industry 	<ul style="list-style-type: none"> Provide advances in production pathway 	<ul style="list-style-type: none"> Additional properties

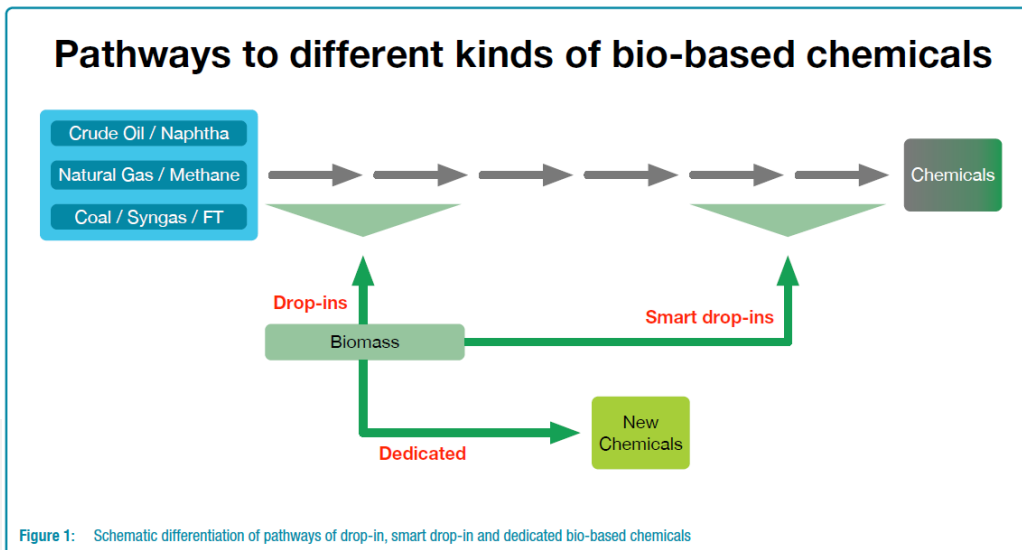


Figure 1: Schematic differentiation of pathways of drop-in, smart drop-in and dedicated bio-based chemicals

Source: Carus *et.al.* 2017 Bio-based drop-in, smart drop-in and dedicated chemicals, nova-Institut

Business cases of RoadToBio



Product group	Feedstock		
	Sugar/Starch	Vegetable oil	Rest streams/other
Platform chemical	Lactic acid 1,4-Butanediol	Ethylene Glycerol	Furfural Methanol
Solvent			
Adhesive			
Agrochemical			
Lubricant			
Plastic	PEF		PHA
Man-made fiber			
Coatings		Dodecanedioic acid (DDDA)	
Surfactant			

Drop-in, Smart drop-in, Dedicated

Stakeholder workshop of RoadToBio on 19.06.18 in Brussels



Aim of this workshop

- Introduce business cases to stakeholders
- Validate data
- Collect insights of stakeholder to set the Roadmap on the right path

Date

- 19 June in Brussels

Participants:

- 20 participants
 - Industry
 - Associations
 - Academics
 - NGOs



Thank you for your participation

Stakeholder workshop: Approach



Divide the chemicals in four groups

Drop-In chemicals

- Ethylene
- Methanol

Smart Drop-In chemicals

- 1,4-Butanediol
- Dodecanedioic Acid

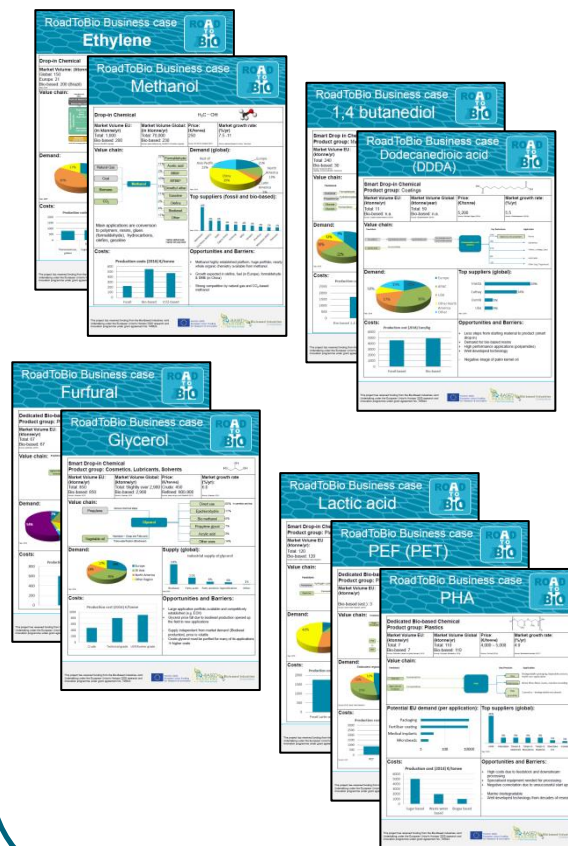
Dedicated chemicals

- Furfural
- Glycerol

Polymer-based dedicated chemicals

- Lactic Acid
- PEF
- PHA

Fact sheets for introducing chemicals to stakeholders



Analysis of the weaknesses, strengths, opportunities and threats via SWOT analysis with the experts

RoadToBio Business case Lactic acid	
Smart Drop-in Chemical Product group: Plastics (Polymers)	
Strengths	Weaknesses
Opportunities	Threats



Polymer-based dedicated chemicals



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Workshop results: Focus on polymer-based dedicated chemicals

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Key feedback received from the stakeholder workshop



Necessary stakeholder input

Key feedback **received** from stakeholders

- | | |
|---|--|
| <ul style="list-style-type: none">• Approach to development of business cases | <ul style="list-style-type: none">• Validation by chemicals industry stakeholder |
| <ul style="list-style-type: none">• Data quality | <ul style="list-style-type: none">• Review data given in case studies |
| <ul style="list-style-type: none">• Data gap | <ul style="list-style-type: none">• Provide missing data |
| <ul style="list-style-type: none">• SWOT analysis | <ul style="list-style-type: none">• Assessment of case studies |
| <ul style="list-style-type: none">• Barriers | <ul style="list-style-type: none">• Key barriers for EU bio-based industry |
| <ul style="list-style-type: none">• Roadmap | <ul style="list-style-type: none">• Provide views on the roadmap |

High-level stakeholder feedback: **New materials with improved functionality represent the largest opportunity for EU bio-based industry**



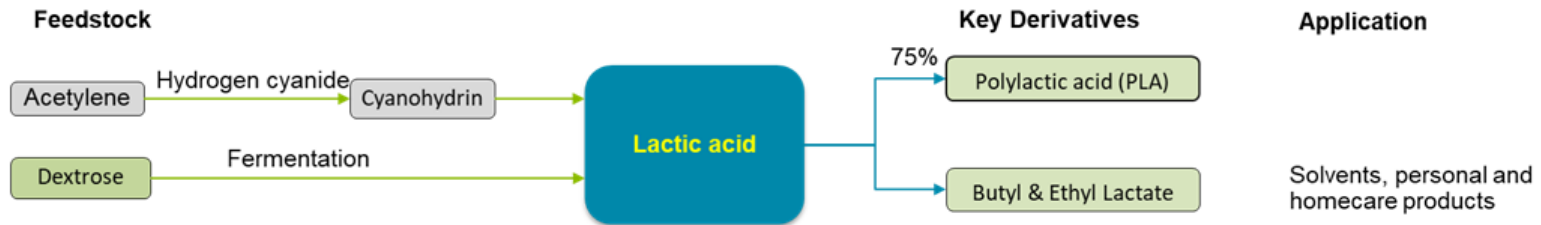
- Dedicated chemicals and polymer-based dedicated chemicals get most of attention - offer new and improve functionality in end products
- Production of bulk chemicals is not cost competitive in Europe – feedstock cost and availability in other regions
- Some of the smart drop-ins have small EU production volumes or small downstream markets in the EU – this may be a weakness

Lactic Acid (PLA) Case study

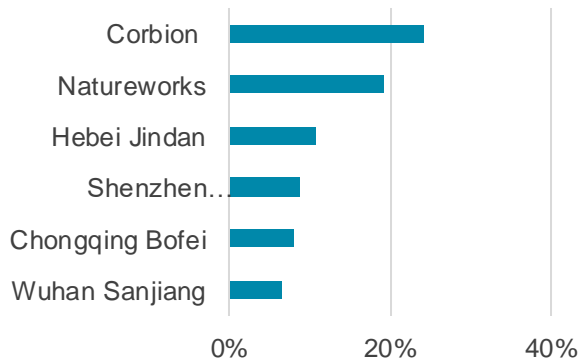


Market Volume EU (ktonne/yr): Total: 120 Bio-based: 120 <small>Source: 2016, CNBC & Grand View Research</small>	Market Volume Global: (ktonne/yr) Total: 1,200 Bio-based: 1,200 <small>Source: 2016, CNBC & Grand View Research</small>	Price PLA: (€/tonne) Given for PLA – key derivative of lactic acid 2,600 <small>Source: Plastics Insight (October 2017)</small>	Market growth rate (%/yr): 15.5  <small>Source: 2016, CNBC & Grand View Research</small>
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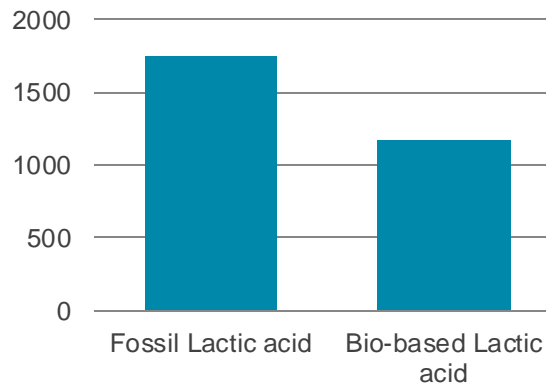
Value chain: today all lactic acid is bio-based



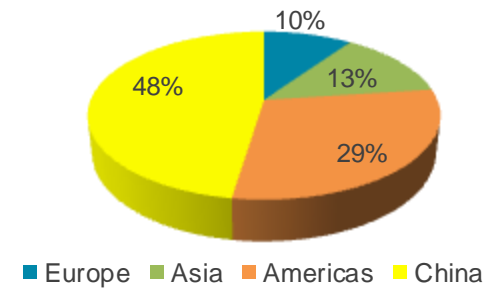
Top suppliers (global)



Production costs (2017) €/tonne*



Demand



Year: 2016



*Estimated



Year: 2016



Lactic acid: SWOT analysis



Strengths

- Several market opportunities
- Nontoxic and biodegradable as a solvent
- Lower price than other biodegradable polymers

Weaknesses

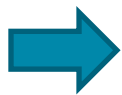
- Brittle polymer
- Additives/plasticizers for improved performance often not biodegradable or bio-based
- No higher volumes to applications other than plastics
- No established recycling stream

Opportunities

- Chemical recycling
- Development of full recycling process

Threats

- No advanced functionalities compared to other plastics



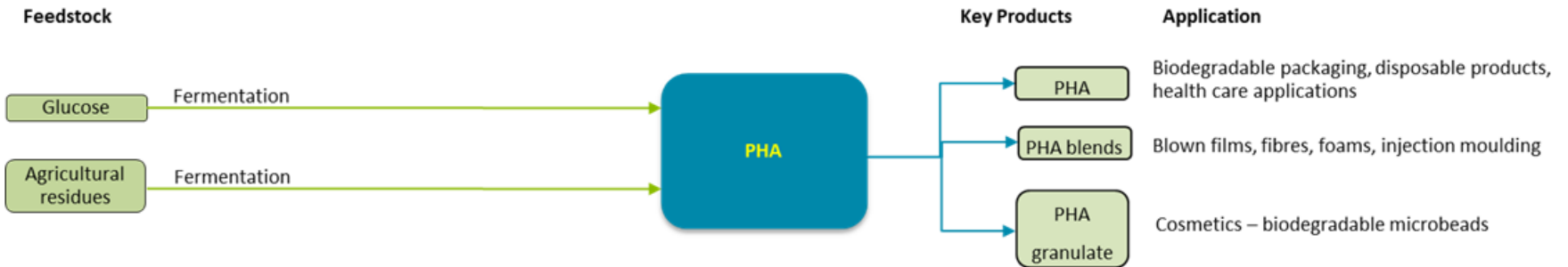
Cheapest among biodegradable bio-based polymers → to grow volumes new applications are needed and/or improved recycling characteristics

PHA Case study

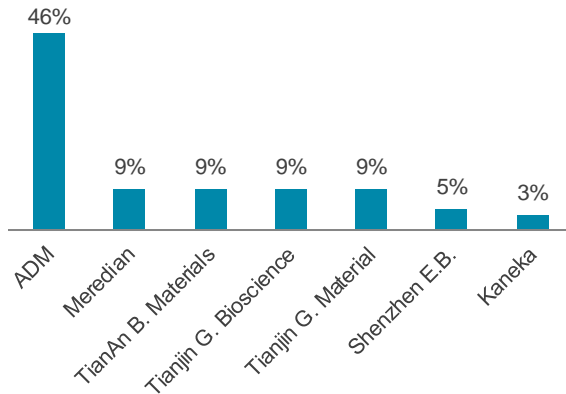


Market Volume EU: (ktonne/yr) Total: 7 Bio-based: 7 <small>Source: Estimation based on global demand, 2015</small>	Market Volume Global (ktonne/yr) Total: 110 Bio-based: 110 <small>Source: European Bioplastics, 2018</small>	Price: (€/tonne) 4,000 – 5,000 <small>Source: De Hart (2014)</small>	Market growth rate: (%/yr) 4.9 <small>Source: Marketsandmarkets (2017)</small>
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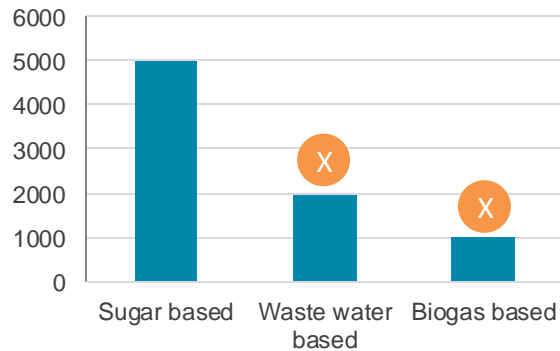
Value chain



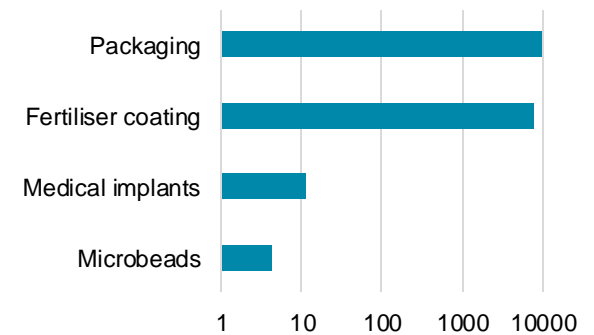
Top suppliers (global)



Production costs (2014) €/tonne*



Potential EU Demand (per application)



PHA: SWOT analysis



Strengths

- Best bio-based bio-degradable polymer
- Good barrier properties

Weaknesses

- Only quality is biodegradability (no other special qualities showing)
- Downstream processing expensive – very diluted product
- Not suitable for long-time use (because it is biodegradable)

Opportunities

- Fertilizers application (slow releasing)
- Development of full recycling process
- New applications: filler or rheology modifier for home and personal care products/cosmetics

Threats

- Competes with cheaper fossil and bio-based polymers (PEF)



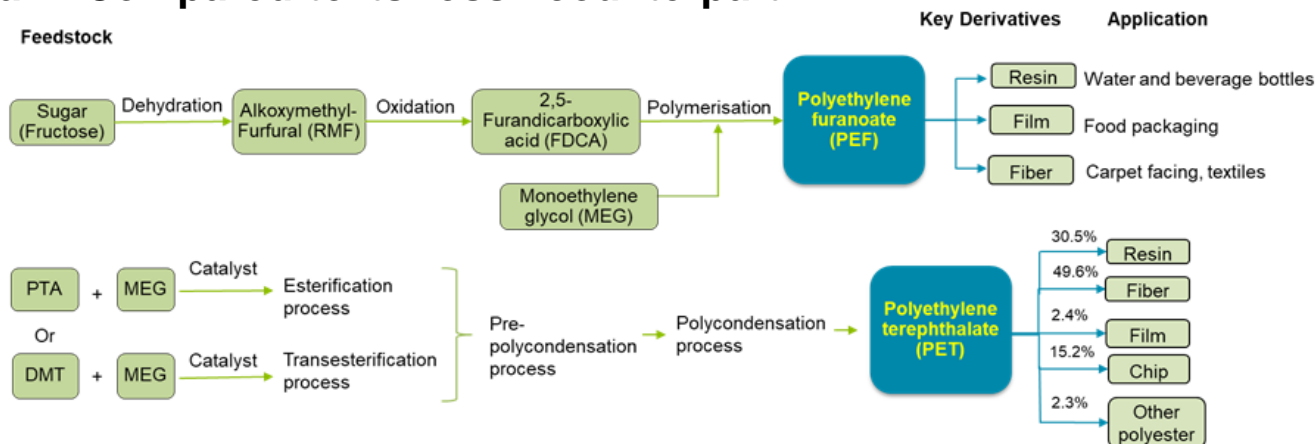
Possibly the best biodegradable polymer → reducing production costs and developing new applications are likely to create market opportunities

PEF (PET) Case study

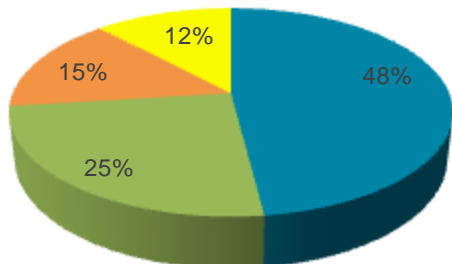


Market Volume EU: (ktonne/yr)	Market Volume Global: (ktonne/yr)	Price: (€/tonne)	Market growth rate: (%/yr)
Bio-based (est.): 3 <small>Source: Grand View Research (2016)</small>	Bio-based (est.): 12 <small>Source: 2016, Grand View Research (2016)</small>	PET price represents the market price PET: 1,100 <small>Source: ICIS (2018)</small>	6 – 8.8 <small>Source: Grand View Research (2016)</small>

Value chain: Compared to its fossil counterpart: PET



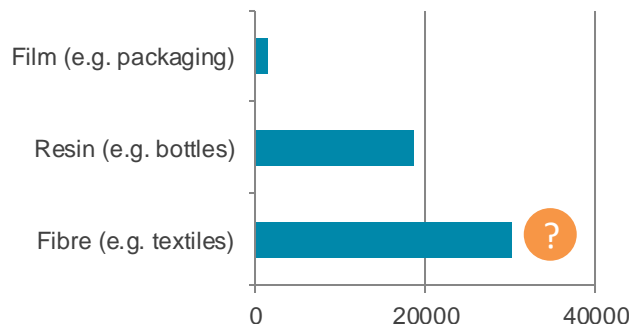
Estimated regional demand of PEF (2016)



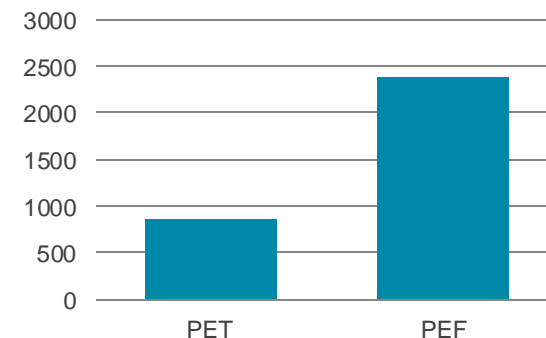
■ Asia ■ Europe ■ N. America ■ Other regions

Source 2016: Grand View Research

Potential demand (global) (2016)



Production costs (2018) €/tonne



Source: ICIS

PEF: SWOT analysis



Strengths

- Improved functionality e.g. mechanical strength and better barrier properties

Weaknesses

- Not easily recyclable
- Production costs are high

Opportunities

- Development of full recycling process
- Easily used in higher volume applications
- Could be used in lesser amount than PET for same application

Threats

- Competition with PET, bio-PET, PTF
- Big focus on recyclability in Europe – circular economy



Enhanced functionality in packaging applications → competes with cheaper fossil and bio-based drop-in plastics

Lessons learned for dedicated polymers



Circular economy: Strong demand for recyclable bio-based polymers

Challenges & opportunities:

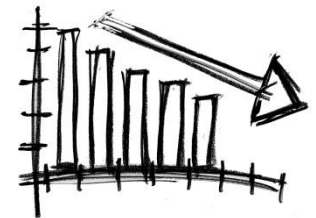
- Find way to separate from mixed plastics
- Establish dedicated recycling streams



Look for **applications other than packaging** → biodegradable films for farming, fillers or microbeads for cosmetics, biomedical materials, automotive, electronics and other fields

Make dedicated chemicals cost competitive:

- Lower production costs - technology development
- Switch to cheaper feedstock - waste streams vs. sugars



Results of the survey on key barriers for bio-based products



Key actors
Government/ Policy makers/NGOs
Scientific and Educational institutions (e.g. Universities)
Industry/SMEs
Society and media

Time horizon	Description
Short-term <2 years	Immediate action needed
Mid-term <5 years	Action needed in the next 2 – 5 years
Long-term > 5years	Action needed in

Barrier	What	When	Who
	What is the action that needs to be taken	What is the time horizon to take the action	Who is the key actor to address this barrier
e.g. Technology not available at commercial scale	Invest in R&D and innovation	Short-term/Mid-term	Industry/ SME & Universities

Key barriers according to bio-based industry stakeholders

Barrier	Action	Time frame	Actor
Fossil benchmark / Low price fossil resources	Carbon tax	Short-term	Government
High CAPEX	Invest in R&D/ Subsidise FOK plant	Mid-term	Industry/SME/ Government
REACH/ health & safety	Simpler procedures for obviously non-toxic components/ SME funds for REACH registration	Short-term	Government/ Industry

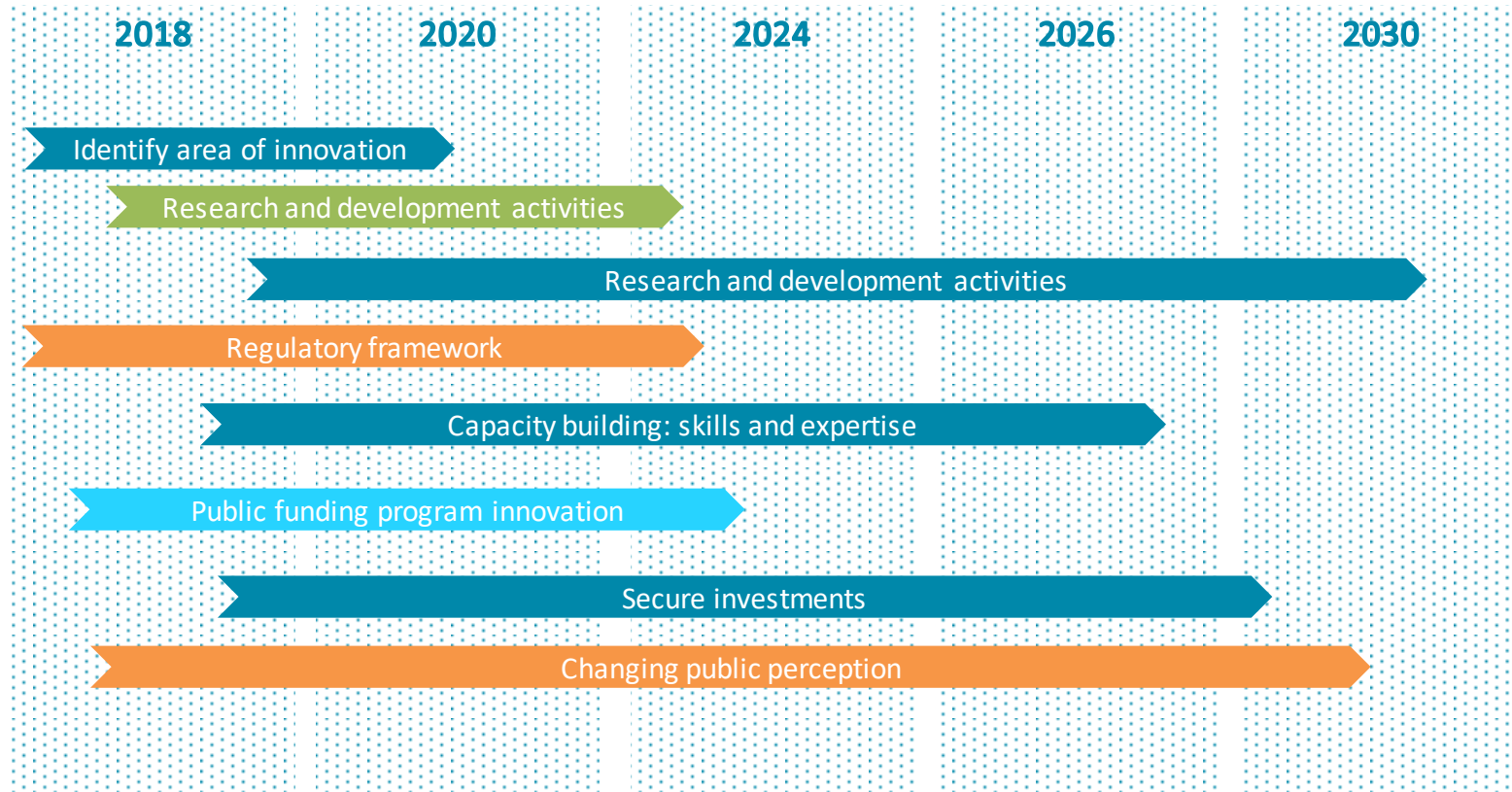
Concept of the Roadmap: Barriers, actors and actions



Barrier characteristic :

- Short-term
- Mid-term
- Long-term

Concept of the Roadmap: Action plan



Industry & SMEs

Scientific & Education institutions

Government/Policy makers & NGOs

Society & media



Q & A

This project has received funding from the Bio-Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No. 745623.



Thank you for your attention.



For Further information:

Visit our website www.roadtobio.eu

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