Welcome and Introduction
Stakeholder workshop
DECHEMA e.V.: Kathrin Rübberdt, Lea König, Jochen Michels

RoadToBio
Roadmap for the chemical industry towards a bioeconomy

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.
<table>
<thead>
<tr>
<th>Time</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.30 – 13.30h</td>
<td>Lunch and registration</td>
</tr>
<tr>
<td>13.30 – 13.45h</td>
<td>Welcome and Introduction</td>
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<tr>
<td></td>
<td>DECHEMA e.V.</td>
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<tr>
<td>13.45 – 14.00h</td>
<td>Quiz: “What does bio-based mean?”</td>
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<td>DECHEMA e.V.</td>
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<tr>
<td>14.00 – 14.15h</td>
<td>Selection criteria of the sweet spots</td>
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<tr>
<td></td>
<td>BTG Biomass Technology Group B.V.</td>
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<tr>
<td>14.15 – 14.35h</td>
<td>Introduction of the sweet spots</td>
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<tr>
<td></td>
<td>E4tech (UK) Ltd</td>
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<tr>
<td>14.35 – 14.45h</td>
<td>Coffee break</td>
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<tr>
<td>14.45 – 16.00h</td>
<td>Discussion on bio-based sweet spots for the chemical industry</td>
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<td></td>
<td>The aim is the validation of the business cases together with stakeholders related to the different sweet spots</td>
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<td></td>
<td>Moderator: nova-institute for ecology and innovation</td>
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<tr>
<td>16.00 – 16.10h</td>
<td>Wrap-up of the workshop, outlook</td>
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<td>DECHEMA e.V.</td>
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</table>
Project RoadToBio

- Duration time: 24 Months
  May 2017 – April 2019

- Budget: 996.000 €

- Consortium:

  - Funded by: BBI – Bio-Based Industries Joint Undertaking
    - Public-Private Partnership established in 2014
    - Developing sustainable and competitive bio-based industries in Europe
    - Partners: European Union (via EC) and Bio-based industries Consortium (BIC)
Status quo: Organic raw material (feedstock) use in the European Union chemical industry

Material use (in total):
- Bio-based feedstock: 7.8
- Fossil-based feedstock:
  - Mineral oil derivates: 57.8
  - Natural gas: 12.3
  - Coal: 0.7
Strategic objectives of BBI for 2020 and 2030 defined in SIRA

“The BBI initiative will contribute to and trigger industrial deployment of bio-based chemicals, biomaterials and advanced biofuels, so that: 20 % of the chemicals and materials in Europe will be bio-based by 2020 rising to 25 % in 2030, compared to 10 % in 2010”.

How can the chemical industry reach the strategic objective of at least 25 % and the total volume of 19.7 mio. tonnes of renewables feedstock use?
Main objective of the RoadToBio-project

To develop a roadmap for the chemical industry that shows the path towards an at least 25 % share of bio products in the organic chemical industry that meet societal needs in 2030.
Main components of the roadmap

Roadmap for the Chemical Industry

Analysis
- Regulations
- Hurdles
- Acceptance
- Most promising opportunities
- Smart Drop-ins
- Dedicated molecule

Enablers
- Regulations
- Acceptance

Action plan
- Strategy
- Action plan
- Engagement guide
Product application groups

Chemical Branches of RoadToBio

- Lubricants
- Plastics
- Solvents
- Surfactants
- Agro-chemicals
- Cosmetics
- Paints, Coatings, Dyes
- Adhesives
- Man-made fibres
Project work plan, main outcomes and stakeholder involvement

Outcome:
- Identification of bio-based opportunities to step in existing value chains
- Most attractive bio-based opportunities
- 9 representative business cases

Markets, technologies and feedstock analysis

Outcome:
- Analysis of regulatory framework and public acceptance

Development of the Roadmap

Outcome:
- Action plan
- Engagement guide

Roadmap for the chemical industry towards a bioeconomy

Outcome:
- Public perception
- Regulatory barriers and enablers of bio-based sector
- Connection of bio-based production and Circular economy

stakeholder
Stakeholder-based process

We need Your input!
Quiz
„What does bio-based mean?“

Stakeholder workshop
DECHEMA e.V.: Lea König, Jochen Michels, Kathrin Rübberdt

http://www.fvaweb.eu/biochallenge/
In cooperation with the BBI funded Project BIOWAYS and StarProBio (GA No. 720762 and GA No. 727740)
RoadToBio
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Consortium:

Selection criteria of the sweet spots
19 June 2018
Dr. Jurjen Spekreijse
Introduction of the Work package

- **Technology, Markets & Feedstocks analysis**

- **Goal:** creation of a sound fact-base for the preparation of the roadmap:
  - Current status of bio-based technology platforms
  - Scout possibilities for bio-based products in the chemical industry (Deliverable published)
  - Priorities of the chemical industry when developing new products or markets (Previous workshop)
  - Long-list of opportunities for the chemical industry, including ranking to identify ‘sweet spots’ (This presentation)
  - Business case studies for 9 sweet spots for bio-based products (Next presentation)
Introduction of the Work package

Long-list of opportunities for the chemical industry, including ranking (This presentation)

• Identify ‘sweet spots’
  – sweet spots:
    “most attractive opportunities for the production of bio-based chemicals by the chemical industry”

• Nine sweet spots are being investigated with case studies
  ➢ Inform the roadmap
  ➢ Not required to reach 25% renewables with just these 9 chemicals
Context and purpose of this workshop

Overview of bio-based technology platforms and products (TRL ≥ 6)

Map of markets for chemicals and their value chains per NACE class

Overlap = Possibilities

Ranking for market potential and ease of implementation

Creating and ranking long list → Sweet spots

Draft criteria for sweet spots

Industry workshop

IV’s with stakeholders

Priorities chemical industry for selection of business cases

Select 9 business cases

Investigate 9 business cases

Validation workshop

Input roadmap

Desk study

Industry engagement
Ranking the long list

- Rank the chemicals on two axes:

<table>
<thead>
<tr>
<th>Ease of entry</th>
<th>HIGH</th>
<th>Opportunistic</th>
<th>Sweet spots</th>
</tr>
</thead>
<tbody>
<tr>
<td>Function of technology readiness level, regulatory push /market pull</td>
<td>Opportunistic</td>
<td>Easy to implement, but the market factors are not favourable.</td>
<td>Sweet spots</td>
</tr>
<tr>
<td>Low</td>
<td>Lower Priority</td>
<td>Less attractive opportunities and not easy to implement. There may be still opportunities for individual bio-based chemicals</td>
<td>Invest to improve</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Market Factors (Size of the price)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Function of (potential) market size, market growth potential, etc.</td>
</tr>
</tbody>
</table>

- Input from the chemical industry used to further define these terms
Ranking the long list

Important criteria determined during the workshop on June 2017

• Size of the price
  ➢ Product market price
  ➢ Production volume

• Ease of implementation
  ➢ Technology Readiness Level
  ➢ Feedstock availability
  ➢ Improved performance

• Soft criteria:
  – Type of product (dedicated, drop-in, smart drop-in)
  – Potential for green premium
Ranking the long list

Input from interviews with stakeholders
- Single phone interviews with 14 chemical industry experts (Companies and associations)

Conclusions
- Development of new (bio-based) products or processes is market driven as well as innovation
- Most criteria are important to high important
- The products groups with the highest growth potential: Plastics, Cosmetics, Coatings
Ranking the long list

Factors considered for ranking the chemicals

Size of the prize

- **Market Volume**
- **Market Price**
- **Market Growth** = Estimated CAGR
  - Global > EU data
  - Drop-in/Smart drop-in considered petrochemical counterparts
  - Data collected through research (Literature, contacts), gaps filled with estimates

Ease of Entry

- **TRL level**
- **Regulatory push / market pull** – related to end products
  - No feasible approach to rate push/pull instruments

➢ Data gathered for all bio-based products on the long list
Ranking the long list

Ranking chemicals after data collection

• Decision to split chemicals into groups
  – Drop-ins, Smart Drop-ins, Dedicated Chemicals

• Individual weighting of „size of the price“ factors for these groups to accommodate for their different markets
  – Drop-Ins compete with larger petrochemical markets, dedicated chemicals rather target new markets.
  – Drop-Ins: 50% volume, 25% price, 25% growth rate
  – Smart DI: 40% volume, 20% price, 40% growth rate
  – Dedicated: 0% volume, 60% price, 40% growth rate

• Traffic light scheme for ranking
  – Top 25% green, middle 50% yellow, bottom 25% red

• Ease of entry used as cut-off criteria at TRL<6
Identification of the sweet spots

**Smart Drop-Ins**

- Acetic anhydride
- Cetyl alcohol
- Hopanol (2,3-)
- Fumaric acid
- Maleic acid
- Butanediol (1,4-)
- Epoxy resins
- Butyric acid
- Acrylic acid
- Dodecanedioic acid
- Ethanol

**Size of the price (20% volume, 40% price, 40% growth rate)**
Business cases

Identification of the business cases

• Not simply the top ranked chemicals

• Versatile selection
  ➢ Chemical type (drop-in, smart drop-in, dedicated)
  ➢ Feedstock type
  ➢ Application sector

• Each partner selected nine candidates, the resulting 20 options were discussed until an agreement on 9 business case topics was reached.
## Sweet spots

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

Dedicated, Drop-in, Smart drop-in
RoadToBio
Roadmap for the chemical industry towards a bioeconomy

Duration time: 24 Months; May 2017 – April 2019
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Consortium:

Introduction to business cases
2nd Industry Expert Group Workshop, 1190 Brussels
Mladen Crnomarkovic (E4tech)
Business cases

- **WP 1:** Markets, Technologies and Feedstocks Analysis
- Partners involved: Nova, BTG, DECHEMA and E4tech

**Task 1.2:** Identified sweet spots

- 1. 1,4-Butanediol
- 2. Dodecanedioic acid
- 3. Ethylene
- 4. Furfural
- 5. Glycerol
- 6. Lactic acid
- 7. Methanol
- 8. PEF
- 9. PHA

**Task 1.4:** Development of business cases

- Case study
- SWOT analysis

**Learnings**

**WP4:** Roadmap development

M9 \(\rightarrow\) M14 \(\rightarrow\) M15
Importance of business cases for the development of roadmap

• Learnings:
  – Status of European bio-based industry
  – Different type of chemicals require different market approach (drop-in vs. dedicate, bulk vs. specialty)
  – What drives market uptake of bio-based chemicals
  – What are the challenges and barrier of bio-based industry
  – Opportunities for EU bio-based industry (sector and type of chemicals)

• Inform the roadmap:
  – **Who** needs to be engaged to achieve the 25% by 2030 target (key actors)
  – **What** needs to be done to overcome barrier and seize the opportunities of bio-based industry (action list)
  – **When** is the action required (time horizon)
Framework for developing business cases

- **Value chain assessment**
  - Bio-based vs. Fossil: feedstock, technology..
  - Where and how the chemical is used

- **Demand** & **Supply**
  - Bio-based vs. Fossil: facts and figures
  - Trends and industry structure

- **Cost evaluation**
  - Bio-based vs. Fossil: cost performance
  - What drives the costs

- **Barriers & Opportunities**
  - Key actors of EU bio-based industry
  - Requirements to overcome barriers and achieve the goal of 25% by 2030

**SWOT Analysis**

- Key actors of EU bio-based industry
- Requirements to overcome barriers and achieve the goal of 25% by 2030
Value chain assessment

• Aim to provide better understanding bio-based and fossil chemicals value chain and how they compare in terms of:
  – Technology: development status, complexity, options
  – Feedstock supply: availability, security, sustainability,
  – Benefits in terms of GHG reduction, LCA or carbon utilization
• What are derivatives and applications of the chemical
• Key advantages and disadvantages of the value chains

Feedstock
- Acetylene
- Formaldehyde
- Butynediol
- Hydrogenation
- Hydroformylation
- 4-OH Butyral
- Hydrogenation
- Fermentation
- Succinic Acid
- Hydrogenation

Key Derivatives
- 1,4 Butanediol

Key Derivatives
- <1% PBS
  Biodegradable packaging
- 8% PU
  Lightweight and durable parts for the automotive, construction and electronics
- 25% PBT
  High performance resin for automotive and electronic components
- 14% GBL
  Solvent for cleaning
- 50% THF
  PTMEG – Spandex & elastomers

Application
- In case of dedicated chemicals - no fossil counterpart – identified proxy fossil chemical this bio-based chemical is likely to replace or compete with
  – e.g. PEF to replace PET
Market analysis

- Aim to analyse the characteristics of the chemicals markets and industry today, and assess their EU and globally outlook to 2030: Which markets are likely to grow? Which are likely to be driven by sustainability? Technologies to be commercialised? Feedstock security?

**Demand:**
- Analysis of key market characteristics: volumes, growth, prices
- Market drivers & trends (economic, environmental, societal, policy)
- Sustainability requirements for downstream application (or per sector)
- For dedicated chemicals assess market potential based on proxy fossil chemical

![Graph](chart.png)

**Global demand (kta)**

- CAGR 7%
- 2016: 1000
- 2030: 6000

**Supply:**
- Characteristics of global and EU bio and fossil industry: production volumes, key players, industry supply chain
- Feedstock availability, security, imports dependency.
- Technology: TRL, challenges and commercialisation status.
Cost evaluation

• Aim is to identify what drives the production costs of bio-based and fossil based chemicals and obtain insight into:
  • Current and future cost drivers
  • If and where is the economic advantage of bio-based chemical over its fossil based counterpart
  • Where are the opportunities to improve the competitiveness of the bio-based chemical
  • Business opportunity which a specific bio-based chemical could represent

Cost models are based on literature and publically available information – challenges of getting recent and good quality data for: feedstock costs, capex and opex.
Barriers & opportunities

- Barriers and opportunities are summarized based on the value chain, market and cost analysis.

- Barriers and opportunities are categorized according to different factors which are likely to require different strategy and are likely to be addressed by different bio-based industry stakeholders:
  - Commercial barriers e.g. product prices, production costs,
  - Technical barriers e.g. technology development, feedstock availability, product performance, etc.
  - Environmental e.g. GHG emissions, land use
  - Policy e.g. incentives, green procurement, laws
  - Social barriers e.g. perception and social acceptance
  - Standards/labelling e.g. REACH, Nagoya protocol for use of GMO organisms
We need your help…

• Validation of the approach to develop business cases:
  – Anything missing in our approach or not needed?
  – Effectiveness of the approach to address different type of chemicals (e.g. dedicated)?
  – Verify data gathered so far
  – How to deliver good quality results?
• Help us close data gaps: missing data & data quality
• Give us your view on barriers and opportunities for bio-based chemicals
On behalf of the project consortium: Thank you for your engagement!

For further information:
Visit our website www.roadtobio.eu
Subscribe to our monthly newsletter
Contact: lea.koenig@dechema.de

Webinar:
“Bio-based sweet spots for the chemical industry – A conclusion and discussion after the second stakeholder workshop”
on 11 July 2018 at 13:00 h CEST
WP4: Roadmap content

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 carry out these activities.

- **Benefits**: Benefits from the level of deployment assessed in terms of: market uptake/shares, GHG reduction, job creation
## WP4: Roadmap concept – barriers/actors/actions

<table>
<thead>
<tr>
<th>Potential barrier</th>
<th>Overcoming strategy /activity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Government/Policy makers &amp; NGOs</td>
</tr>
<tr>
<td>Barrier 1</td>
<td>Action actor 1</td>
</tr>
<tr>
<td>Barrier 2</td>
<td>Action actor 1</td>
</tr>
<tr>
<td>Barrier 3</td>
<td>Action actor 1</td>
</tr>
<tr>
<td>Barrier 4</td>
<td>Action actor 1</td>
</tr>
</tbody>
</table>

Barrier characteristic:
- **Short-term**
- **Mid-term**
- **Long-term**
WP4: Roadmap concept – action plan

- **2018**: Identify area of innovation
- **2020**: Research and development activities
- **2024**: Regulatory framework
- **2026**: Capacity building: skills and expertise
- **2030**: Public funding program innovation

**Government/Policy makers & NGOs**

**Scientific & Education institutions**

**Industry & SMEs**

**Society & media**
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Introduction to the workshop
19 June 2018
Christopher vom Berg
Introduction

2nd workshop in the RoadToBio project

Goal: Validating business cases

We have prepared 9 posters, one for each of the selected business cases
Introduction

2nd workshop in the RoadToBio project

Goal: Validating business cases

We have prepared 9 posters, one for each of the selected business cases

Poster contain information about:

- Market data
- Value chain overview
- Demand
- Supply
- Production costs
- Key opportunities and barriers
Workshop approach

- Form 4 groups of similar size
  - Everyone should have received a ticket assigning you to a group

- In the 4 corners of this room you will find:
  - 2-3 project partners
  - Posters about 2-3 business cases
  - Empty SWOT forms to collect feedback
  - Sheets asking about your perceived main barriers for the bio-based chemistry
Workshop approach

• 3 rounds of discussion:
  – Start: Each group moves to one corner.
  – **Discuss** the posters and **note feedback** as a group on the SWOT form
  – After some time (R1: 20 min, R2: 15 min, R3: 10 min) rotate clockwise to the next table
  – Moderator gives a **quick summary** of previous round(s)
  – New round adds onto findings and discussion of previous rounds

• Additionally, you can fill out the provided sheet about barriers:
  – We ask you to **list** the **main barriers for bio-based chemicals** and give your opinion of who, what and when should act to address these barriers.
Visualisation of the workshop

Group A
- Drop-Ins
- Ethylene
- Methanol

Group B
- Dedicated (polymer)
- PEF
- PHA
- Lactic Acid

Group C
- Smart Drop-Ins
- DDDA
- Butanediol

Group D
- Dedicated:
  - Furfural
  - Glycerol
Visualisation of the workshop

Group D
- Drop-Ins: Ethylene
- Methanol

Group A
- Dedicated #2:
  - PEF
  - PHA
  - Lactic Acid

Group C
- Dedicated:
  - Furfural
  - Glycerol

Group B
- Smart Drop-Ins:
  - DDDA
  - Butanediol
Visualisation of the workshop

Group D

Short summary

Group A

Short summary

Group C

Short summary

Group B

Short summary
We need your help

- **Validation** of the approach to develop business cases:
  - **Anything missing** in our approach or not needed?
  - Effectiveness of the approach to address different type of chemicals (e.g. dedicated)?
  - **Verify data** gathered so far
  - How to deliver good quality results?

- Help us **close data gaps**: missing data & data quality

- What are **specific trends** resulting in market growth rates (for a chemical in general, and specifically for the bio-based chemical)

- Give us your view on **barriers** and **opportunities** for bio-based chemicals

- Tell us about your **personal opinions** and **expectations** for the selected bio-based chemicals and bio-based chemistry in general!
On behalf of the project consortium: Thank you for your engagement!

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