

# Bio *SPRINT*

## Biorefining of sugars via Process Intensification

Research and Innovation action (RIA) – Horizon 2020-BBI-2019-SO2-R6

Improve biorefinery operations through process intensification and new end products

### D7.6 TECBP plan and strategy



Bio-based Industries  
Consortium



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<b>Lead Beneficiary</b>	NIC		
<b>Responsible Author</b>	Blaž Likozar, NIC, blaz.likozar@ki.si		
<b>Contributions from</b>	Karoline Wowra (DEC), Lea König (DEC)		

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## Glossary of terms and abbreviations used

Abbreviation / Terms	Description
AEP	AEP Polymers SRL
BBI JU	Bio-based Industries Joint Undertaking
D&C	Dissemination & Communication
DEC	Dechema Gesellschaft für Chemische Technik und Biotechnologie E.V.
EFCE	European Federation of Chemical Engineers
FI	Finland
ICT	Information and communications technology
IT	Italy
MSc	Master of Science
NIC	National Institute of Chemistry
PI	Process Intensification
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
SI	Slovenia
TECBP	Training, Education & Capacity Building Programme
UK	United Kingdom
UNEW	University of Newcastle Upon Tyne
UOULU	Oulun Yliopisto (University of Oulu)
WP	Work Package
5-HMF	5-Hydroxymethylfurfural

## 1 Executive Summary

The goal of the BioSPRINT project is to efficiently utilize and valorize hemicellulose streams including upstream purification, catalytic conversion followed by downstream purification to ultimately end with polymerization to consumer ready products. The project focuses towards 'zero-waste' bio-based operations and applying an integrated biorefinery concept. This will embody the cascading principle 1) upstream purification, 2) catalytic conversion, 3) downstream purification and 4) polymerization to create new hemicellulose-derived products and maximize conversion of the lignocellulosic biomass feedstock into higher value-added products. The TECBP (Training, Education & Capacity Building Programme) aims to enhance the skills of the stakeholders, spread and promote the philosophy, knowledge and results of BioSPRINT, with the overall objective to valorize previously discarded side streams that were originally considered too costly to utilize.

The TECBP activities include the delivery of 4 online modules, 4 training & capacity-building workshops as well as the organization of a BioSPRINT Summer School. When delivering the TECBP activities, attention will be paid to select a broad gender-balanced audience among academia, industry and other BBI JU stakeholders. Together with the WP1-4 leaders and partner EBOS, it is planned to develop, implement, and deliver four online-access training modules, introduced via live webinars, to a large academic, research and industrial audience. The modules will emphasis on one or several of the BioSPRINT focus areas regarding the process intensification (PI) of biorefining operations. This training and educational task will continue with the organization of four TECBP workshops (in four distinct countries: Finland, Italy, Slovenia, and United Kingdom) which will be implemented during the 3<sup>rd</sup> year of the project (2023). In the scope of TECBP, the BioSPRINT Summer School will be organized in the 4<sup>th</sup> year of the project where partner DEC, together with the WP1-4 leaders, will organize a five-day Summer School which will provide advanced training and transferability potential studies on the four focus areas studied in BioSPRINT. The strategic plan and short summaries of all activates referring to TECBP are summarized in this deliverable.

**Deliverable Keywords:** plan and strategy, online modules, webinar, workshop, summer school, bioeconomy, biorefinery, BioSPRINT, hemicellulose, lignocellulose, biomass

## 2 Introduction

The TECBP (Training, Education & Capacity Building Programme) task within the BioSPRINT project aims to enhance the skills of participants to disseminate and promote BioSPRINT knowledge, principles, and results by providing various activities for a wide audience of academia, research and industry partners.

This deliverable *D7.6 TECBP plan and strategy* provides a strategic tentative plan and brief summary of the scheduled activities described in Task 7.2 Training, Education & Capacity Building programme (TECBP) in the future of the project. The TECBP activities include the delivery of four **online modules**, four **training & capacity building workshops** and the **BioSPRINT Summer School**.

Four online modules will be given in webinar form on the topics of PI technologies for separation and solid handling processes, process intensification for catalytic biomass conversion, industrial perspectives on biomass feedstock and bio-based products and downstream processing approach. The workshops will be organized by WP1-4 leaders in four different countries, Slovenia, Italy, Finland and United Kingdom, where each of them will focus on their specific field and topic within the BioSPRINT, namely upstream purification of hemicelluloses streams, catalytic conversion of hemicellulose sugars into monomers, downstream purification of furan monomers and polymerization (see Figure 1). The third activity planned within TECBP is a Summer School, taking place in year 2023/2024, targeting a large and diverse audience including students and researchers from industry and academia.

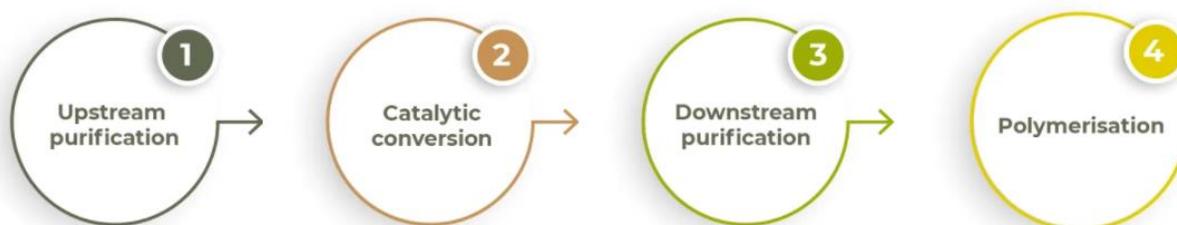


Figure 1: BioSRPRINT activity areas

### 2.1 Goal of the Training, Education & Capacity Building programme (TECBP)

The TECBP is designed to deliver and promote the skills and knowledge of BioSPRINT project to the large academic, research and industrial audience and potential end-user stakeholders. The goal of TECBP is planned to be achieved by four online modules, four training & capacity-building workshops and a BioSPRINT Summer School.

## 2.2 Mapping Projects' Outputs

Table 1: Adherence to BioSPRINT's GA Deliverable & Tasks Descriptions

BioSPRINT Task		Respective Document Chapter(s)	Justification
Task 7.2 Training, Education & Capacity Building programme (TECBP)	The task 7.2 includes 4 subtasks with activities including delivery of 4 online modules, 4 training & capacity-building workshops as well as the BioSPRINT Summer School. When delivering the TECBP, attention will be paid to select a broad gender-balanced audience among academia, industry.	<p><b>Chapters 1-2-3</b></p> <p><b>Objective 7</b> (Dissemination &amp; exploitation): <b>To fully exploit the project's results</b> by means of multidimensional D&amp;C, stakeholder engagement, Training &amp; Capacity-building, standardisation and business planning activities</p> <p><b>Sub-objectives</b></p> <p><b>SO7.2:</b> To plan, organise and deliver a TECBP around 3 pillars:</p> <p><b>a)</b> Online modules delivered by end of year 2 w.r.t. to the 4 areas of technological interest for BioSPRINT,</p> <p><b>b)</b> Training and transferability workshops organized by UOULU, UNEW, NIC, FhG and AEP in year 3,</p> <p><b>c)</b> Organisation of the BioSPRINT Summer School under the supervision of DEC in year 4.</p>	<ul style="list-style-type: none"> <li>• The preliminary contents of the webinars, workshops and summer school</li> <li>• Tentative timetable of the TECBP activities</li> </ul>
<b>BioSPRINT Deliverable</b>			
<p>D7.6 TECBP plan and strategy</p> <p>The deliverable, continuously updated afterwards, presents the TECBP implementation objectives, means and planned activities.</p>			

### 3 TECBP Plan – Overall structure

#### 3.1 Webinars

The BioSPRINT webinars are aiming at providing training modules and information on selected BioSPRINT topics. The target groups are students and young researchers. The webinars will be held in English. EBOS will provide technical support in the form of computer-aided tools and ICT development. The support will come through the creation and maintaining an online repository storing all the teaching materials. The materials will be in pdf and video form, and they are going to be available to the appropriate audience before and after the webinars. Prior to any webinar, if needed, the material will be accessible to authorized users only. The online repository will be maintained for a few years after the end of the project.

In the following tables 2 - 5 the main structure and a short description on the content of the planned webinars is provided.

#### Webinar No.1

Table 2: Description and structure of webinar No.1

Webinar title	Responsible partner	Target group	Date	Duration
PI technologies for separation and solid handling processes	UOULU and UNEW	Students, young researchers	November 2021	90 min
<b>Description</b>				
The webinar will explain the generic concept of Process Intensification (PI) for chemical processing, its benefits and methods typically used in its implementation. The application areas will focus on separation and solid handling processes. The technologies such as spinning disc and hybrid membrane systems will be introduced. Application examples to solids handling and purification of liquid streams are highlighted. The webinar will also be part of MSc level course ' <i>Advanced Separation Processes</i> ' in UOULU, and as part of the MSc in Sustainable Chemical Engineering at UNEW.				

## Webinar No.2

Table 3: Description and structure of webinar No.2

Webinar title	Responsible partner	Target group	Date	Duration
Process Intensification for catalytic biomass conversion	NIC and UNEW	Students, young researchers, industry	February/March 2022	90 min
<b>Description</b>				
<p>This webinar will provide an overview to process intensification in catalysis and reaction engineering, following the application of process intensification to catalytic biomass conversion, including integration of catalyst development and microkinetic with intensified reactor design. The concepts of intensification through field enhancement, diffusion enhancement and hybridization of technologies will be explained and illustrated alongside case studies on oscillatory flows and thin films, microreactors, and reactive extraction. This webinar will be organized in collaboration with the Special Interest Group in Catalysis and Reaction Engineering, Institution of Chemical Engineers. This webinar will also be provided as part of the MSc in Sustainable Chemical Engineering at UNEW.</p>				

## Webinar No.3

Table 4: Description and structure of webinar No.3

Webinar title	Responsible partner	Target group	Date	Duration
Industrial perspectives on biomass feedstocks and bio-based products	AEP Speakers: AEP, Prefere, UPM	open (industrial audience, researchers, students)	April 2022	90 min
<b>Description</b>				
<p>This webinar will provide an overview to the conversion of biomass derived molecules into chemical structures for application in the polymers' industry. The webinar will cover the development of new bio-based products, starting from the perspective of the biorefineries that provide the necessary biomass streams, and then describing the different development scales from the laboratory to pilot until the industrial level. The BioSPRINT industrial partners will explain their approach to cope with the complexity and variability of bio-based starting materials used in synthetic protocols.</p> <p>The presence of companies of very different size will be the occasion to hint non-technical but very relevant aspects, such as the diverse business models adopted in the chemical and bio-based industry for the exploitation of the results, the REACH compliancy of novel products and the protection of the related intellectual property rights.</p> <p>This webinar will also be provided as part of the MSc in Sustainable Chemical Engineering and as part of the MSc in Renewable Energy, Enterprise, and Management at UNEW.</p>				

## Webinar No.4

Table 5: Description and structure of webinar No.4

Webinar title	Responsible partner	Target group	Date	Duration
Downstream processing approach	NIC and UNEW	Students, researchers, industrialists	April/May 2022	90 min
<b>Description</b>				
<p>Downstream processing approach will be discussed with the focus to separate main reaction product components, namely furfural and 5-HMF, to a commercial chemical specification, to recycle solvent and unreacted sugars and to remove acids and humins as products from side reactions. Special attention will be given to the choice of solvents for extraction and different configurations of separation schemes for bio-components will be presented and discussed by means of modelling.</p> <p>We will try to connect this webinar with webinars in the frame of the EFCE (European Federation of Chemical Engineers) and specialized group on Fluid Separations.</p>				

## 3.2 Workshops

The workshops will be organized by each of the WP leaders involved in BioSPRINT. In total, four workshops are planned in four different countries, namely Finland, United Kingdom, Slovenia and Italy. Each workshop is a one-day workshop organized by the WP leaders of the BioSPRINT project addressing the four focus areas of BioSPRINT PI (Process intensification) of biorefining operations. In the following, the key topics as well as descriptions on the potential content of the workshops are listed according to the BioSPRINT work packages. Where possible, the planned workshops will be held before or after scientific conferences or general assembly meetings of the BioSPRINT project. Due to the COVID situation, preliminary periods of time are given. A detailed agenda will be elaborated in the upcoming months.

### Workshop No. 1 - Finland

Table 6: Description and structure of workshop No.1

Workshop topic	Responsible partner	Target group	Date	Duration
Upstream Purification of Hemicelluloses Streams	OULU	Academic research and industrial audiences	To be dated, Preliminary date: <i>September/ October 2022*</i>	One day - Workshop
<b>Description of the topic</b>				

In BioSPRINT, the key PI strategy will be the development of hybrid membrane technologies as low-energy solutions to remove soluble non-sugar components and concurrently achieve higher concentration of hemicellulose sugars. The membrane technologies can be combined with e.g., adsorption to ensure high purity of the target sugars. In addition to hemicellulose purification, the workshop topics include improving the overall efficiency of the upstream purification e.g., with intensified pre-treatment steps such as lignin precipitation with spinning disc reactors, and recycling of process water and solvents.

*\*International Conference on Biorefinery Engineering and Biocatalysis July 19 – 20 2022 in Finland; Nordic Wood Biorefinery Conference 2022 Oct 25 – 27 2022 in Finland; World bioeconomy forum October 2022*

## Workshop No. 2 - United Kingdom

Table 7: Description and structure of workshop No.2

Workshop topic	Responsible partner	Target group	Date	Duration
Catalytic Conversion of Hemicellulose Sugars into Monomers	UNEW	Academic research and industrial audiences	To be dated Preliminary date: <i>May/June 2023</i>	One day - Workshop
<b>Description of the topic</b>				
<p>The project will investigate, apply, and integrate catalysis, kinetics and in-situ separation methods of reactive intermediates into a single intensified process step to maximise sugar conversion, reduce generation of waste by-products, minimise hazardous solvent inventory and energy consumption, and improve process safety. Additionally, intensification via hybridisation of reaction and extraction techniques will be investigated to enable in-situ removal of highly reactive target products avoiding further degradation in the reactor. Integration between catalyst and reactor design will be achieved using high throughput and machine learning methods for catalyst development, leading to more selective processes using less harsh process conditions. This will lead to an efficient reactor design, reducing reactor and downstream separations footprint.</p>				

*\*\* Process Intensification Network meeting at Newcastle University May/June 2023*

**Workshop No. 3 - Slovenia**

Table 8: Description and structure of workshop No.3

Workshop topic	Responsible partner	Target group	Date	Duration
Downstream Purification of Furan Monomers	NIC	Academic research and industrial audiences	To be dated Preliminary date: <i>August 2023</i>	One day - Workshop
<b>Description</b>				
<p>In downstream purification processes, BioSPRINT will focus on the recovery of product(s), solvent(s) and unreacted sugar feedstock. Additionally, it might be necessary to remove short chain acids, humins and other unwanted by-products, generated in parallel dehydration reactions, to guarantee maximum product quality downstream. Similarly, to the upstream purification units, emphasis will be directed towards integration and intensification of technologies capable of minimising net energy consumption and product degradation, greenhouse gas emissions and costs, associated with downstream separation processes. A session dedicated to PI (process intensification) methods for downstream separation will be held during this workshop.</p>				

**Workshop No. 4 - Italy**

Table 9: Description and structure of workshop No.4

Workshop topic	Responsible partner	Target group	Date	Duration
Polymerization	AEP	Academic research and industrial audiences	To be dated Preliminary date: <i>June or November 2023***</i>	One day - Workshop
<b>Description</b>				
<p>At the final polymerization stage, resole and novolac-type resins and mannich polyols will be synthesized based on the purified bio-based monomers produced, when necessary, in combinations with fossil reagents. Polymerization intensification methods will be investigated to achieve continuous processes using spinning disc reactors, which would replace the current batch-based approaches.</p>				

\*\*\* *European Biomass conference June 2023 (location not known yet) or BioSPRINT GA November 2023*



## 4 Conclusions and Next Actions

Deliverable *D7.6 TECBP plan and strategy* presents the detailed information and systematic plan of future activities that will be implemented within the Task 7.2 Training, Education & Capacity Building programme. The subtask *7.2.2 BioSPRINT online TECBP* will be delivered through online accessible training models in the form of webinars in the second year of the project. This will specifically include four different topics relevant to the BioSPRINT project; 1) separation and solid handling processes, 2) process Intensification for catalytic biomass conversion, 3) industrial perspectives on biomass feedstocks and bio-based products and 4) downstream processing approach and will be presented through 4 different webinars held in English. Under the subtask *7.2.3 TECBP workshops*, four training & capacity building workshops will be organized at partners' laboratory sites in their distinct country (FI, IT, SI, UK). The selected themes for workshops are 1) upstream purification of hemicelluloses streams, 2) catalytic conversion of hemicellulose sugars into monomers, 3) downstream purification of furan monomers and 4) polymerization. The third activity described under Subtask 7.2.4 is the *BioSPRINT Summer School*, which will take place in 2023/2024, with detailed planning starting in 2022. This deliverable provides a tentative plan for future activities encompassing Task 7.2 which will be updated continuously as time and travelling allows due to the current situation.