



Deliverable 6.7

## Stakeholder information day

### **Demonstration of solvent and resin production from lignocellulosic biomass via the platform chemical levulinic acid**

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Horizon 2020  
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for Research & Innovation

## About GreenSolRes

The need to establish economic and sustainable large-scale operations for the conversion of renewable resources to chemical building blocks is becoming increasingly urgent in the context of climate change and depleting fossil fuel reservoirs. Pathways for manufacturing of bio-based fuels and chemicals have been developed but often rely on sugar and starch crops for feedstock. The European Demonstration project - GreenSolRes aims at a sustainable and competitive industrial production of the platform chemical levulinic acid (LVA) from non-food lignocellulosic biomass. Further, the conversion of LVA and LVA esters into industry relevant building blocks  $\gamma$ -valerolactone (GVL), 1-methyl-1,4-butanediol (MeBDO) and 2-methyltetrahydrofuran (2-MTHF) will take place by new catalytic methods developed during the course of this project. Finally, these chemicals will be upgraded to solvents and resin monomers to produce high added value adhesives and consumer products.

### Project Coordinator



### Project Office



### Consortium



## About this document

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PU	Public	X
CO	Confidential, only for members of the consortium (including the Commission Services)	

## Publishable Summary

The public Stakeholder information day was held on 30<sup>th</sup> November 2021 hosted by RWTH Aachen University. Due to the ongoing pandemic restriction the event was conducted virtually. The event informed Stakeholders about the project's achievements of all working packages and highlighted the novel pathways of biomass and levulinic acid conversion enabled by the research within the project.

In particular, the conversion of lignocellulosic biomass to levulinic acid and the development of demo plant within WP1, the conversion of levulinic acid and levulinic acid ester to value-added products (GVL, MeBDO and 2-MTHF) within WP2, the application of the value-added building blocks as solvents and adhesive resins within WP3, and LCA and toxicity assessments within WP4 were presented.

## Table of Contents

About GreenSolRes .....	2
About this document.....	3
Publishable Summary .....	4
Table of Contents .....	5
List of Figures.....	6
List of Tables.....	6
1 Introduction .....	7
2 Agenda and highlights.....	8
2.1 Welcome & Introduction to GreenSolRes by the coordinator .....	8
2.2 Levulinic acid production from lignocellulose .....	8
2.3 Hydrogenation of LVA and furfural to GVL, MeBDO and MTHF .....	9
2.4 Prospects of new biobased raw materials for adhesives .....	9
2.5 Commercialisation perspectives for a first 50kt LVA production .....	9
2.6 Question & Answers session.....	9
2.7 Audience .....	10
3 Summary.....	11

## List of Figures

Figure 1-1: Flyer for the Stakeholder information day. ....	7
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## List of Tables

Table 2-1: Agenda of the Stakeholder information day. ....	8
Table 2-2: Participants list. ....	10

## 1 Introduction

The Institute for Technical and Macromolecular Chemistry at RWTH Aachen University hosted the Stakeholder information day on 30<sup>th</sup> November 2021. Due to the ongoing travel restrictions and safety measures resulting from the COVID 19 pandemic the event was held virtually via zoom.

At the Stakeholder information day, project partners were able to present their findings and highlight the achievements that enable efficient processing of lignocellulosic biomass via levulinic acid (ester) to GVL, MeBDO and 2-MTHF and the practical application of these substances (see Figure 1-1).

The aim of the Stakeholder information day was to connect with Stakeholders and identify possible future collaboration and exploitation of the GreenSolRes results.

Stakeholders were invited either directly by the project members, or via professional networks and special interest groups.



10:00 h - **Welcome & Introduction to GreenSolRes by the coordinator**  
(J. Klankermayer, RWTH Aachen University)

10:30 h - **Levulinic acid production from lignocellulose**  
(J. Viell, RWTH Aachen University)

11:00 h - **Hydrogenation of LVA and furfural to GVL, MeBDO and MTHF**  
(J. Klankermayer, RWTH Aachen University; D. Starck, BASF; I. Thiel, BASF)

11:30 h  
**BREAK**

11:45 h - **Prospects of new biobased raw materials for adhesives**  
(A. Brandt, Henkel)

12:15 h - **Commercialisation perspectives for a first 50kt LVA production**  
(B. Winter, J. Viell, RWTH Aachen University)

12:40 h - **Question & Answer session with all project partners**

afterwards  
**END**



Figure 1-1: Flyer for the Stakeholder information day.

## 2 Agenda and highlights

The schedule of the Stakeholder information day was from 10:00 to 12:40 and the agenda is shown in Table 2-1. The agenda was set to chronologically represent the different stages in the conversion of lignocellulosic biomass to bio-based solvents and resins.

Table 2-1: Agenda of the Stakeholder information day.

<b>10:00 h</b>	<b>Welcome &amp; Introduction to GreenSolRes by the coordinator</b> Prof. J. Klankermayer, RWTH Aachen University
<b>10:30 h</b>	<b>Levulinic acid production from lignocellulose</b> Dr. J. Viell, RWTH Aachen University
<b>11:00 h</b>	<b>Hydrogenation of LVA and furfural to GVL, MeBDO and MTHF</b> Prof. J Klankermayer, RWTH Aachen University Dr. D. Starck, BASF SE Dr. I. Thiel, BASF SE
<b>11:30 h</b>	<b>Break</b>
<b>11:45 h</b>	<b>Prospects of new biobased raw materials for adhesives</b> Dr. A. Brandt, Henkel
<b>12:15 h</b>	<b>Commercialisation perspectives for a first 50kt LVA production</b> Dr. J. Viell, RWTH Aachen University B. Winter, RWTH Aachen University
<b>12:40 h</b>	<b>Question &amp; Answer session</b>

### 2.1 Welcome & Introduction to GreenSolRes by the coordinator

Prof. Jürgen Klankermayer has the chair of Translational Molecular Catalysis at RWTH Aachen University and is the coordinator of the GreenSolRes project.

Prof. Jürgen Klankermayer welcomed the audience and presented the agenda of the workshop. Afterwards he introduced the GreenSolRes project, showing how the consortium is connected and how the whole value chain from lignocellulosic biomass to bio-based solvents and resins is covered by the project partners. Great emphasis was given on the collaboration within the project and how the information flow from all disciplines has been vital for the achievements in GreenSolRes.

### 2.2 Levulinic acid production from lignocellulose

Dr. Jörn Viell is the group leader of bioprocess development at the chair for Process Systems Engineering at RWTH Aachen University.

Dr. Jörn Viell started the Stakeholder information day with the first scientific talk, covering the conversion of lignocellulosic biomass to levulinic acid. He presented in detail the different development stages which led to the Biorefinery demo plant, and the challenges associated with building up the setup. Emphasis was given to the purification of the resulting levulinic acid, which is detrimental to allow efficient downstream processing.

### 2.3 Hydrogenation of LVA and furfural to GVL, MeBDO and MTHF

Dr. Dorothea Starck, Global New Business Development, Chemical Intermediates at BASF SE, presented an alternative access to GVL via bio-based furfural value chain.

In a first step she showed the hydrogenation of furfural to furfuryl alcohol using furfural obtained from project partner LENZING. Main focus was set on conversion of furfuryl alcohol to levulinic acid or levulinic acid ester. Emphasis was given on the optimisation of the lab experiments, resulting in successful scale-up of the process to a kg scale in continuous operation.

Dr. Indre Thiel, Sustainability Project Manager Intermediates at BASF SE, followed up by presenting the hydrogenation of the levulinic acid ester to GVL with heterogeneous catalysts. She highlighted the necessity of full conversion in the hydrogenation step, as otherwise purification proves technical challenge during distillation. Further, this process step was scaled up successfully to kg-scale operated in continuous mode (3.2 kg crude GVL/day).

Prof. Jürgen Klankermayer afterwards followed up with the presentation of the homogeneous catalytic conversion of levulinic acid to GVL, MeBDO and 2-MTHF. In particular, the catalyst development, reaction optimisation and successful scale-up from a 1 mL batch reactor to a 900 mL (CSTR) reaction vessel were discussed.

### 2.4 Prospects of new biobased raw materials for adhesives

Dr. Adrian Brandt, Head of Bio-Renewables R&D platform AEE at HENKEL, presented possible applications of MeBDO and 2-MTHF in adhesive resins.

In particular, the polymers, which are synthesized by LIKAT from GVL, MeBDO and 2-MTHF are further modified and formulated to adhesives and sealants by HENKEL.

He showed how 2-MTHF could successfully be used in formulations for pipe adhesives as green solvent. However, the focus of the presentation was dedicated to the use of MeBDO as component in PUR hotmelts. Thus, generating a novel hotmelt prototype which showed promising chemical and mechanical properties, resulting in several market introduction possibilities.

He pointed out that the next step requires industrial players to upscale the production of the needed raw materials, to produce sufficient amounts of hotmelts for market introduction.

### 2.5 Commercialisation perspectives for a first 50kt LVA production

Lastly, in a joint presentation Dr. Jörn Viell and Benedikt Winter (LTT-RWTH) showed the perspectives for a 50kt LVA production plant.

Dr. Jörn Viell showed in a techno-economic analysis that with state-of-art technologies a LVA price of 1.95 €/kg is expected. He then showed optimisation potential of the state-of-art technologies resulting in LVA prices as low as 1.24 €/kg.

Benedikt Winter continued with presenting the results of the Life-Cycle Assessment (LCA). He showed that the global warming impacts can be expected to amount to 0.7-0.8 kg CO<sub>2</sub> eq/kg LVA, this relates to a reduction of the global warming impacts of the bio-based products of 35 – 80% compared to the fossil analogues.

### 2.6 Question & Answers session

At the time of the event it was decided to have short Q&A session after each presentation giving opportunity to ask in-depth questions to the project partners.

Discussions after the talks were moderated by Prof. Jürgen Klankermayer and most questions asked centred around the feasibility of upscaling and market introduction. Taken together, the project partners agreed that the work within GreenSolRes allowed to not only lay a foundation for the valorization of lignocellulosic biomass, but rather showcase that upscaling is possible and an application is possible. Leading to the conclusion that this is the time to engage Stakeholders to establish the next step towards market introduction.

## 2.7 Audience

The Stakeholder information day reached a wide audience from both academia and industry. A list of all participants is shown in Table

**Table 2-2: Participants list.**

<b>First Name</b>	<b>Last Name</b>	<b>Organization</b>
Erik	Abbenhuis	Hybrid Catalysis
Pascal	Albrecht	ITMC RWTH Aachen University
Eleftheria	Athanasiadou	CHIMAR HELLAS SA
Mini	Bajaj	SYNCOM F&E GmbH
Horst	Beck	Henkel AG & Co. KGaAHenkel
Robert	Bischof	Lenzing AG
Magda	Borzecka	IUNG-PIB
Adrian	Brandt	Henkel AG & Co. KGaA
Alexandra	Brautlacht	RWTH Aachen University
Mohammad	Chehadé	Center for Circular Economy - RWTH Aachen
Konstantina	Karydi	CHIMAR HELLAS SA
Anja	Fink	RWTH Aachen University
Thomas	Fischöder	RWTH Aachen University - CMT
Lieve	Geerts	VITO NV
Stefanie	Gottuck	TU Dortmund
Gisela	Hieber	BASF SE
Celine	Jung	Umicore AG & Co. KG
Birgit	Kamm	Wood Kplus, Wood Chemistry and Biotechnology
Kaan	Karacasulu	RWTH Aachen University
Martin	Kavscek	Acies Bio d.o.o.
Jürgen	Klankermayer	RWTH Aachen University
Robert	Konrath	BASF SE
Klaus	Lenz	SYNCOM GmbH
Steffen	Mader	BASF SE
Electra	Papadopoulou	CHIMAR HELLAS SA
Christian	Paulik	Johannes Kepler Universität Linz
Lukas	Polte	RWTH Aachen University AVT.FVT
Peter	Rudolf	BASF SE
Peter	Segers	SUEZ
Bernhard	Stadler	Nordzucker AG
Dorothea	Starck	BASF SE
Veit	Stegmann	BASF SE
Indre	Thiel	BASF SE
Sergey	Tin	LIKAT
Joern	Viell	RWTH Aachen University
Marcus	Vossen	BASF SE
Benedikt	Winter	RWTH Aachen University
Hilda	Witters	VITO
Franz	Zeppetzaer	Komptenzzentrum Holz GmbH

### 3 Summary

The Stakeholder information day hosted by ITMC – RWTH Aachen University was conducted as planned. A vast audience from academia and from industry from 7 countries attended the workshop (Table 2-2).

Representing the GreenSolRes consortium, Prof. Jürgen Klankermayer introduced the objectives and partners of the project. Dr. Jörn Viell highlighted the challenges associated with the demo-scale production of LVA from lignocellulosic biomass. Dr. Dorothea Starck, Dr. Indre Thiel and Prof. Jürgen Klankermayer showcased the different possibilities to convert levulinic acid (esters) with homogeneous and heterogeneous catalysts to the value-added products GVL, MeBDO and 2-MTHF. Dr. Adrian Brandt demonstrated how these value-added products can be used for their application in adhesive resins. Dr. Jörn Viell and Benedikt Winter finished the series of talks with a techno-economic and life-cycle assessment.

In summary, the project partners were able to successfully present the whole value chain from lignocellulosic biomass to application to the public.