LIGNICOAT

Sustainable COATings based on LIGNIn resins and bio-additives with improved fire, corrosion and biological resistance

Léo STACCIOLI, ARDITEC ASSOCIATION

Online workshop, 4th of December 2024

BIORING High-performance Biocoatings

Super Bark

BBI JU
Bio-based Industries Consortium
Horizon 2020 European Union Funding for Research & Innovation

This project has received funding from the Bio-based Industries Joint Undertaking (JU) under the European Union's Horizon 2020 research and innovation programme under grant agreement No 101023342. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Bio-based Industries Consortium.

ARDITEC

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Léo STACCIOLI – ARDITEC Association

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- **Sustainability Engineer**
- **Background in Health & Safety (H&S) Engineering**
- **8+ years of experience in LCA (Life Cycle Assessment) and sustainability evaluations**
- **Part of ARDITEC since 2021**
- **Extensive expertise in collaborative European R&D projects, including proposal writing and execution**

Bio-based Industries Consortium

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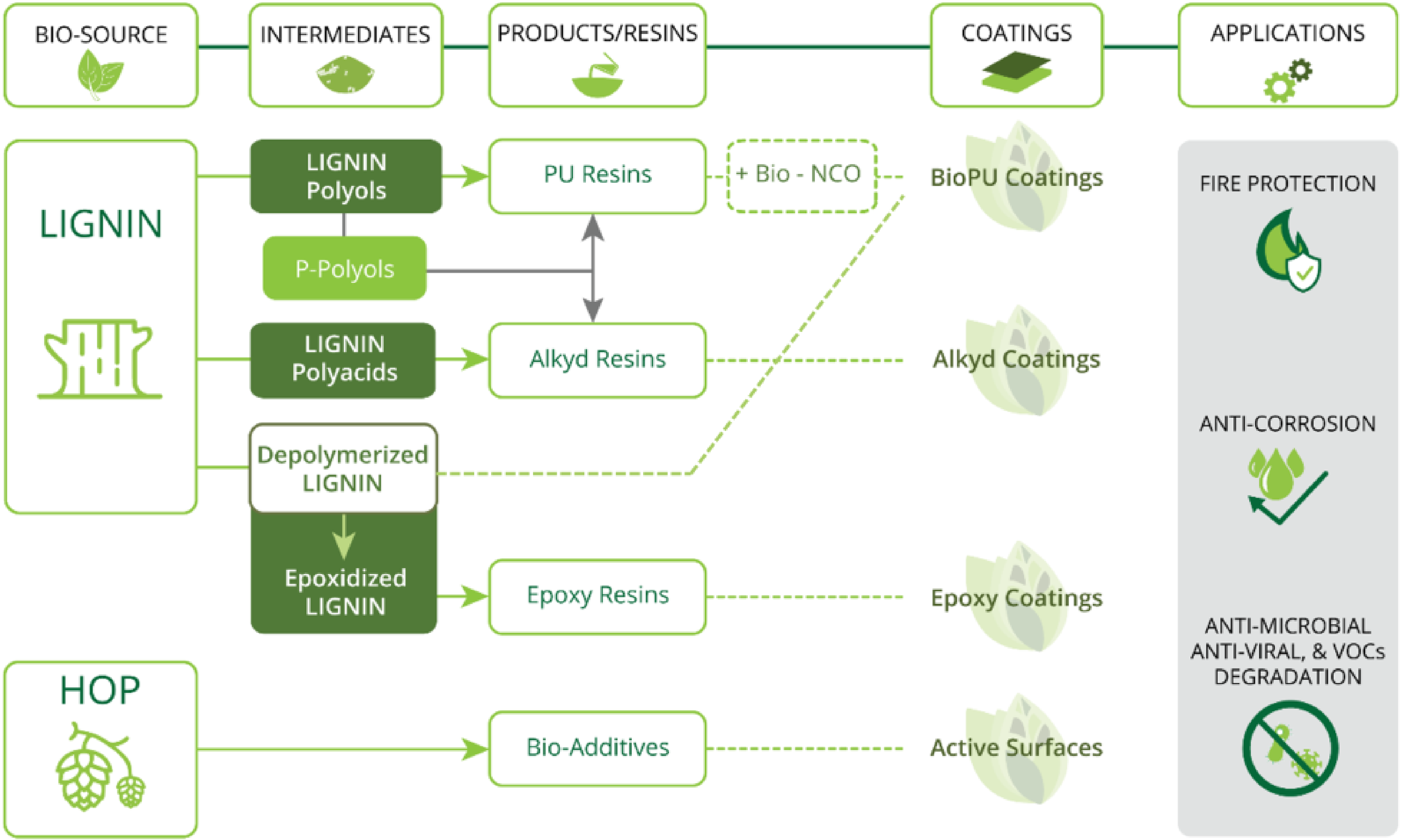
LIGNICOAT - Project overview

From lignin to biocoatings for three different applications



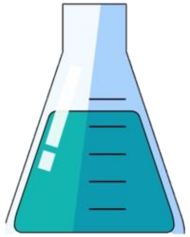
Challenges and critical aspects of the LCA applied to LIGNICOAT

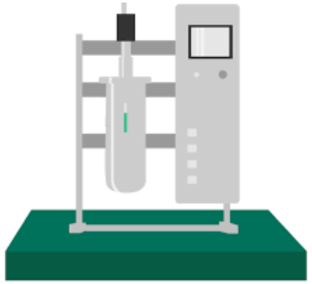
Main challenge: upscaling data from lab to pilot or industrial scale

Life Cycle Assessments are crucial for analyzing and optimizing **emerging technologies**’ conceivable **environmental performance**.

However, emerging technologies are often subject to **high uncertainties** and are still at **laboratory or pilot scale**, necessitating the **scale-up** of LCA relevant data, such as **energy** and **material flows**, to an **industrial level**.

Lab scale → Pilot scale → Industrial scale

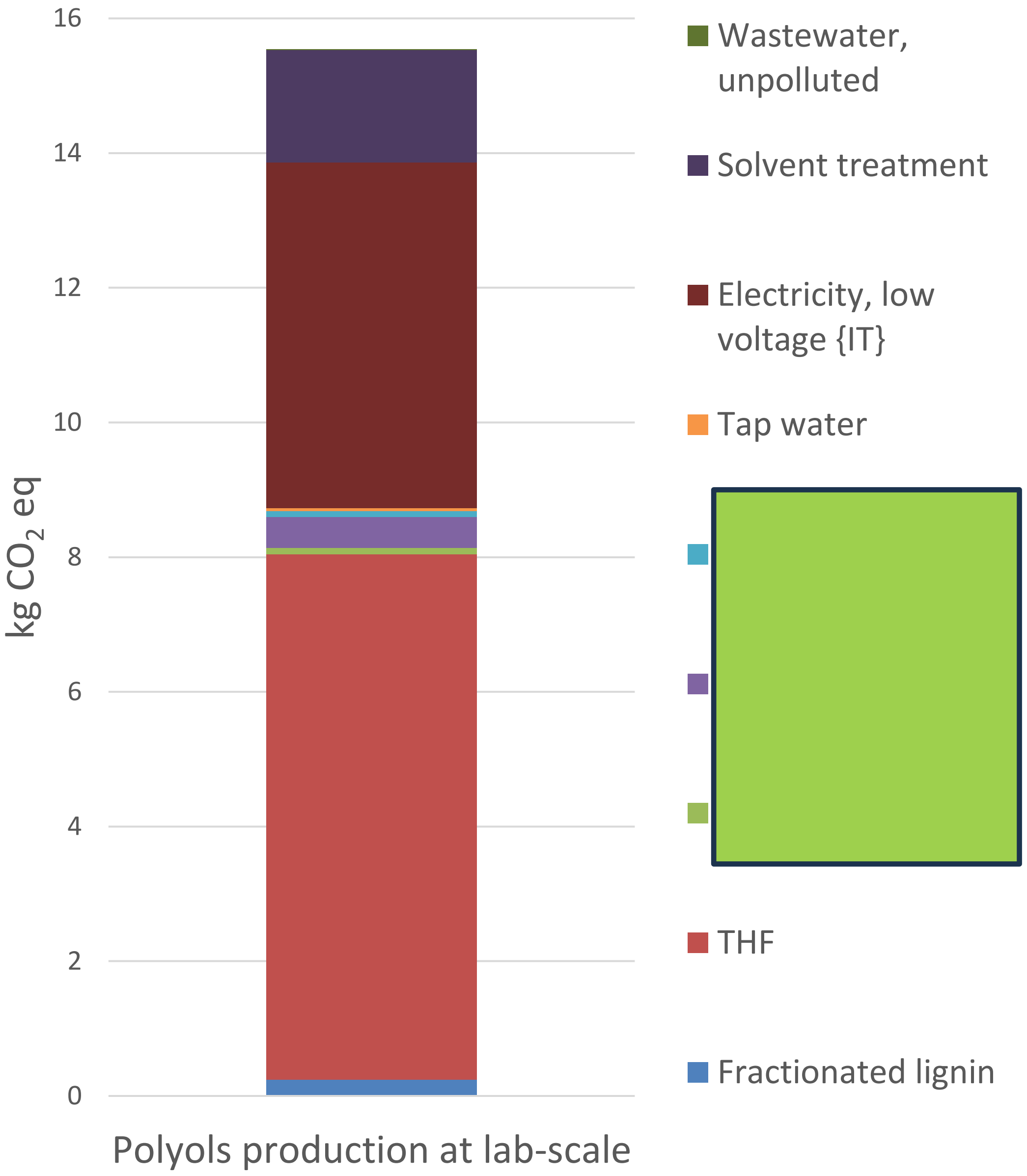




Lab-scale assessment of lignin-based polyols

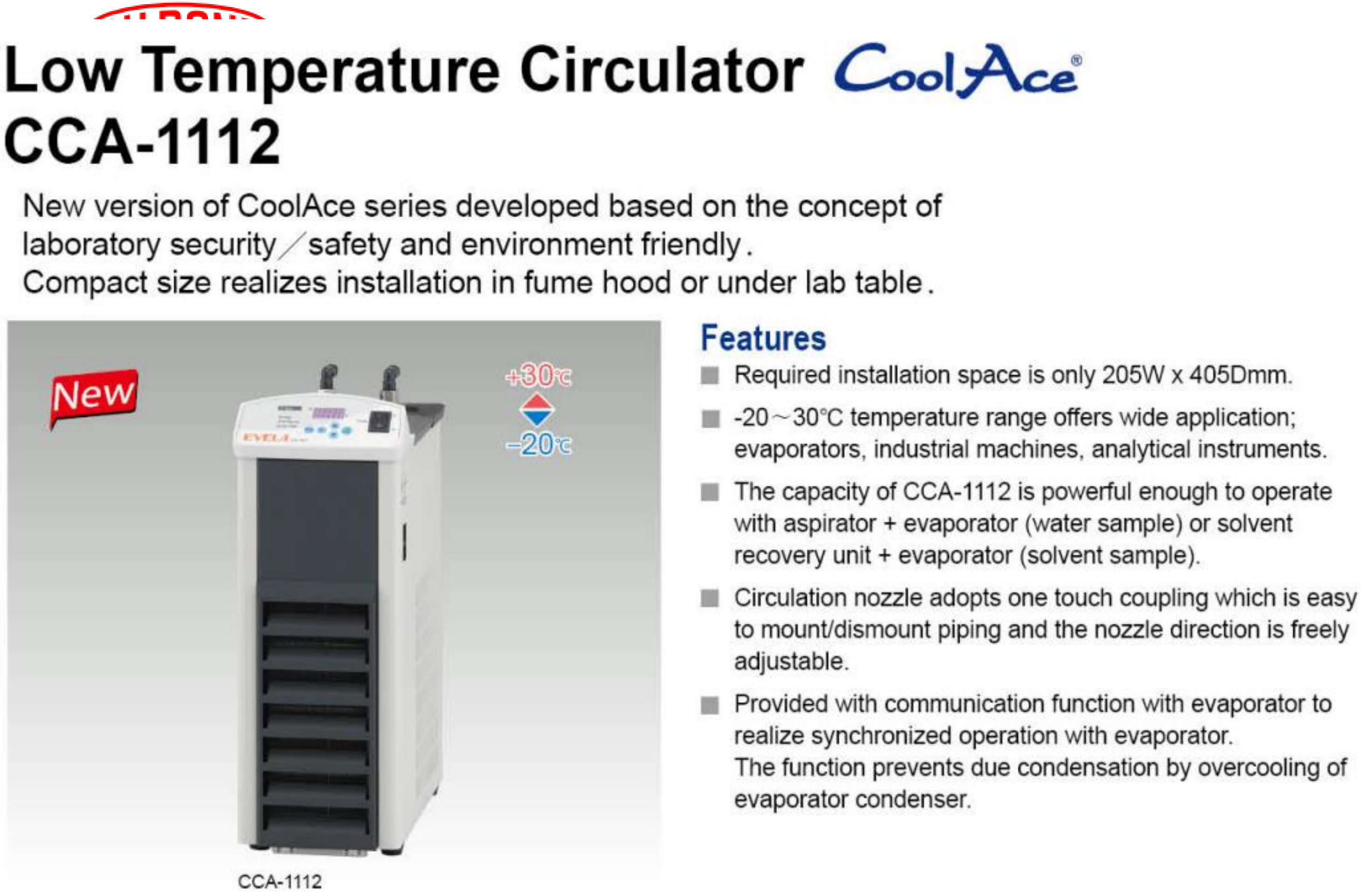
This is the LCI to produce 1kg of lignin-based

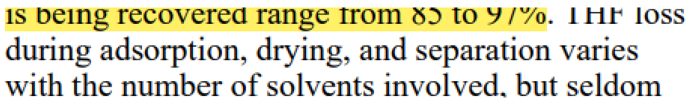
Flow	Normalized amount/FU	
		INPUTS
Fractionated lignin	0,250 kg	
[redacted]	0,129 kg	[redacted]
Tetrahydrofuran (THF)	1,428 kg	Tetr
[redacted]	0,031 kg	[redacted]
[redacted]	0,027 kg	[redacted]
Cooling water flow	0,209 m³	Tap wate
Rotary evaporator	5200 Wh	Electr
Vacuum pump	480 Wh	Electr
Drying oven	9600 Wh	Electr
Overhead stirrer	160 Wh	Electr
		OUTPUTS
Lignin based polyol	1 kg	
Tetrahydrofuran (unknow purity)	0,855 kg	Spent solver
Emissions to water	0,209 m³	Wastev
Traces of remaining volatile compounds	0,010 kg	



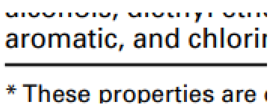
Input/output changed when upscaling the process

- The **tetrah** … 1,4-diol made of sugarcane)
- According t
- The **water**
- For the **sol** … **tor of the synthesis** using a wat
- The **electri** … aporator which were energy-cor … vill be adjusted according t
- **Half of the ele** … uction (assumption).





is being recovered range from 85 to 97%. THF loss during adsorption, drying, and separation varies with the number of solvents involved, but seldom



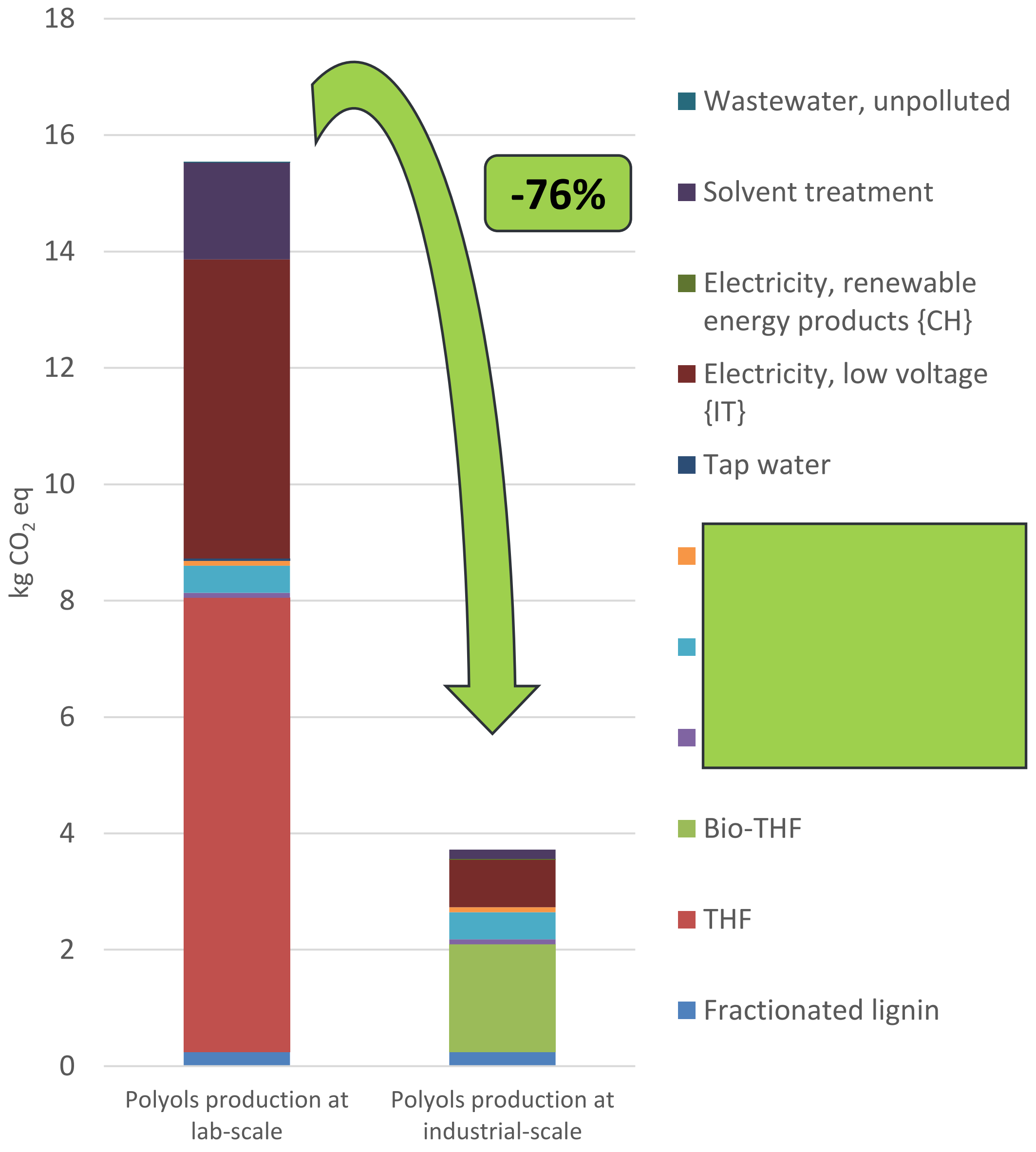
aromatic, and chlori

* These properties are

Significant environmental benefits were demonstrated

Upscaling the process involves updatin

Flow	Normalized amount/FU	
		IN
Fractionated lignin	0,250 kg	
[redacted]	0,129 kg	
Bio-based tetrahydrofuran (Bio THF)	1,428 kg	
[redacted]	0,031 kg	
[redacted]	0,027 kg	
Cooling water flow	0 m^3	
Vacuum pump	240 Wh	
Heating circulator	4000 Wh	
Overhead stirrer	80 Wh	
Low temperature circulator	600Wh	
		OU
Lignin based polyol	1 kg	
Bio-Tetrahydrofuran (unknow purity)	0,085 kg (90% recycled)	
Emissions to water	0 m^3	
Traces of remaining volatile compounds	0,010 kg	



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Results overview - Example

Main findings (hotspots & recommendations)

Environmental

A comparative analysis was conducted between new biocoatings and a fossil-based solvent-borne equivalent. LIGNICOAT biocoating showed strong performance in areas such as Climate Change (CC), Resource Use (RU), and Water Use (WU). However, two key environmental hotspots were identified: 1) Methoxypropanol and 2) Phosphorus fire-retardants. Potential alternatives to mitigate these impacts include using ethanol or isopropanol, as well as bio-based solvents like ethyl lactate or D-limonene, which could offer lower toxicity and a reduced environmental footprint. For fire retardants, nitrogen-based alternatives, bio-based phosphate substitutes, or nano-clay composites may also provide sustainable solutions.

Economic

Sensitivity to Consumption OPEX is also the parameter with highest potential to optimise production cost of fire protection biocoatings. Furthermore, future developments should focus on the optimisation of raw materials and energy, without a significant increase of other costs, particularly in the CAPEX and operational OPEX (labour). Moreover, production capacity, consumption OPEX and market prices constitute also the highest NPV optimisation factors.

Social

Key hotspots identified include generic concerns such as Health & Safety (H&S) practices and incidents and community involvement. A specific area of concern is corruption, which requires attention to maintain ethical standards. Additionally, process hotspot lies in the additives production in Italy, particularly production & acquisition of chemicals, which may pose operational or regulatory risks.
Social benefits include: fostering innovation and enhancing competitiveness through sustainable practices. To mitigate these risks and capitalize on opportunities, it is recommended to strengthen H&S procedures,, ensure community engagement and invest in the development and transfer of technological innovations to improve processes and maintain a competitive edge.

1/ FIRE PROTECTION OF WOOD
LC26T FORMULATION

WP4: BIOCOATINGS FORMULATION

1m² of biocoating complying with standards for fire protection of wood

Climate Change	Production cost
0,593 kg CO_2 eq	3-3,7€/m^2
Single score	**NPV**
54 µPt	+5M€ in 10 ys when sold 9€/m^2

tecnalia

Kraft lignin

Climate Change	Production cost
0,00233 kg CO_2 eq	0,6-0,8€/kg
Single score	
0,11 µPt	

storaenso

Compared to traditional petro-based counterparts:
-47% in kg CO_2 eq
Within AMP range
Positive social impacts

WP2: BIORESINS BASED ON LIGNIN

Bio-PUD based on lignin polyols and bioisocyantes

Climate Change	Production cost
0,297 kg CO_2 eq	9-11€/kg
Single score	
14,6 µPt	

ecoat

WP1: LIGNIN BASED INTERMEDIATES

Lignin polyols (based on fractionated lignin)

Climate Change	Production cost
0,0796 kg CO_2 eq	52-64€/kg
Single score	
3,5 µPt	

AEP tecnalia VTT

Bioisocyanates — vencorex

Climate Change	Production cost
0,0448 kg CO_2 eq	13,5-16,5€/kg
Single score	
2,3 µPt	

AMP: Average Market Price
NPV: Net Present Value
PUD: Polyurethane Dispersion

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Thank you

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