Applying Safe and Sustainable by Design to bio-based adhesives and coatings: Insights from the SuperBark project

Panagiotis ISIGONIS – Joint webinar – Online, 19/05/2026

LIST, VTT, RTU, ICP, TECNALIA, HFA

All SuperBark partners

Circular Bio-based Europe Joint Undertaking

Co-funded by the European Union

Bio-based Industries Consortium

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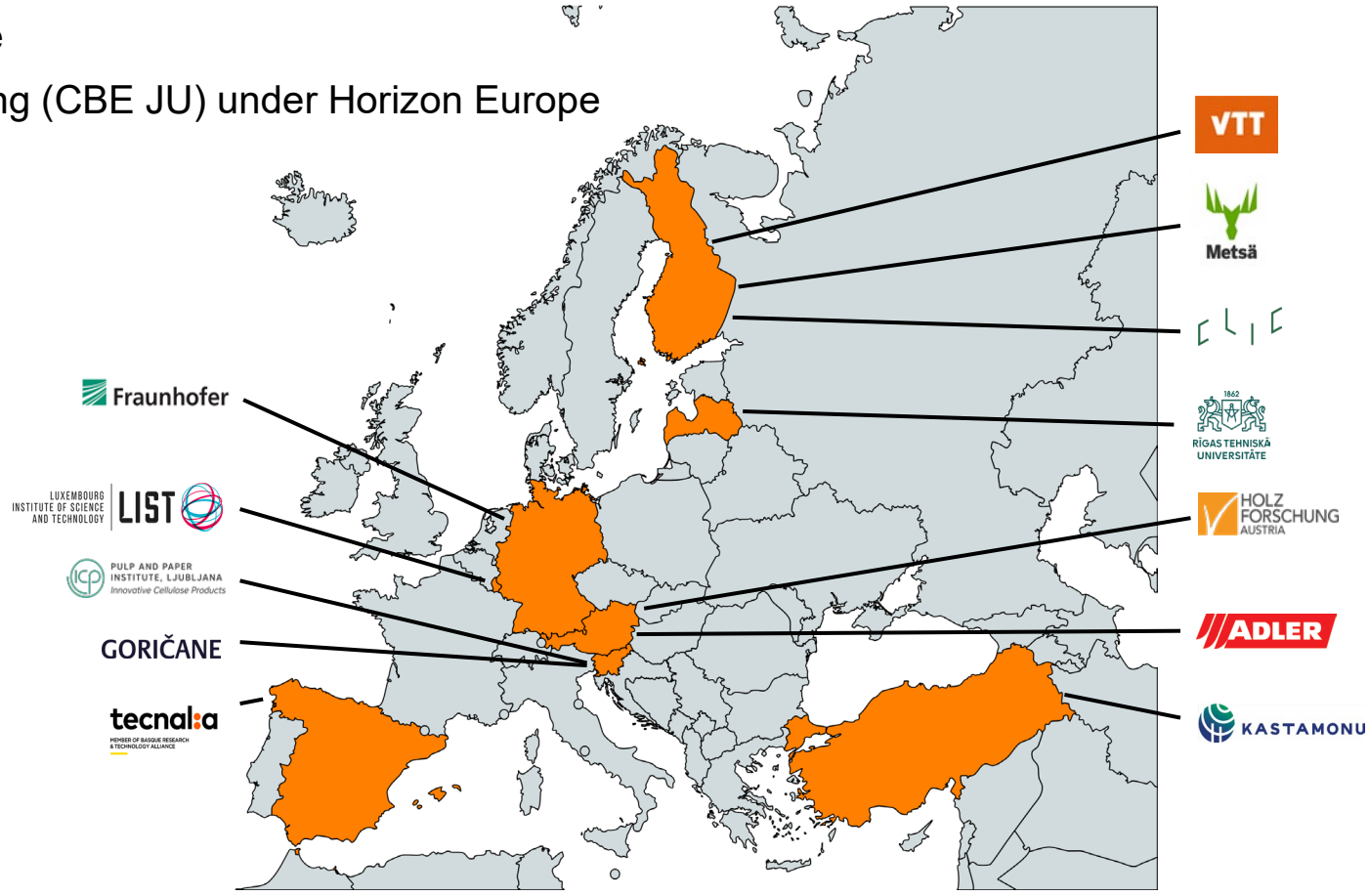
SuperBark - 12 Partners, 8 Countries

About SuperBark

- EU Consortium of 12 partners from 8 countries (6 RTOs, 1 University, 1 SME, 4 Large companies)
- Coordinated by VTT, Finland's leading research centre
- Funded by Circular Bio-based Europe Joint Undertaking (CBE JU) under Horizon Europe
- Budget: 4.5 M€
- Time frame: 09/2023 - 08/2027 (48 months)

Diverse Expertise

- Multi-disciplinary project
- Various fields:
  - Biology
  - Chemistry
  - Physics
  - Wood industry
  - Wood research
  - Paper industry and research
  - Material Science
  - Chemical Engineering
  - Design
  - Economics



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SuperBark scope and solution

- Development of safe, sustainable, and high-performance >95% **bio-based adhesives and coatings** from industrial softwood bark, that is a major side stream from the forest industry.
- Application in wood: **Adhesives** for **plywood, particleboard and medium-density fibreboard (MDF)**.
- Application in wood and paper: **Coatings for plywood and packaging paper**.
- Improve environmental and safety performance, alongside recyclability

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Super Bark

Objectives

1 **Produce bio-based components** from industrial softwood bark, **using novel alkaline extraction** and membrane-assisted separation technologies.

2 **Develop adhesives with >95% bio-based content** from polyphenols extracted from bark for plywood, particleboard and medium-density fibreboard.

3 **Develop coatings with >95% bio-based content** from bark-based cellulose nanofibrils and polyphenols for plywood and packaging paper.

4 **Apply a Safe and Sustainable by Design framework** to support the design of adhesives and coatings using bark components.

5 **Develop digital tools** including process design, data analytics and system dynamics modelling **to support the scale-up and market integration** of the adhesives and coatings.

6 Communicate, disseminate and **exploit the outcomes of the project to relevant stakeholders** to increase awareness of the new technologies, products, and associated opportunities.

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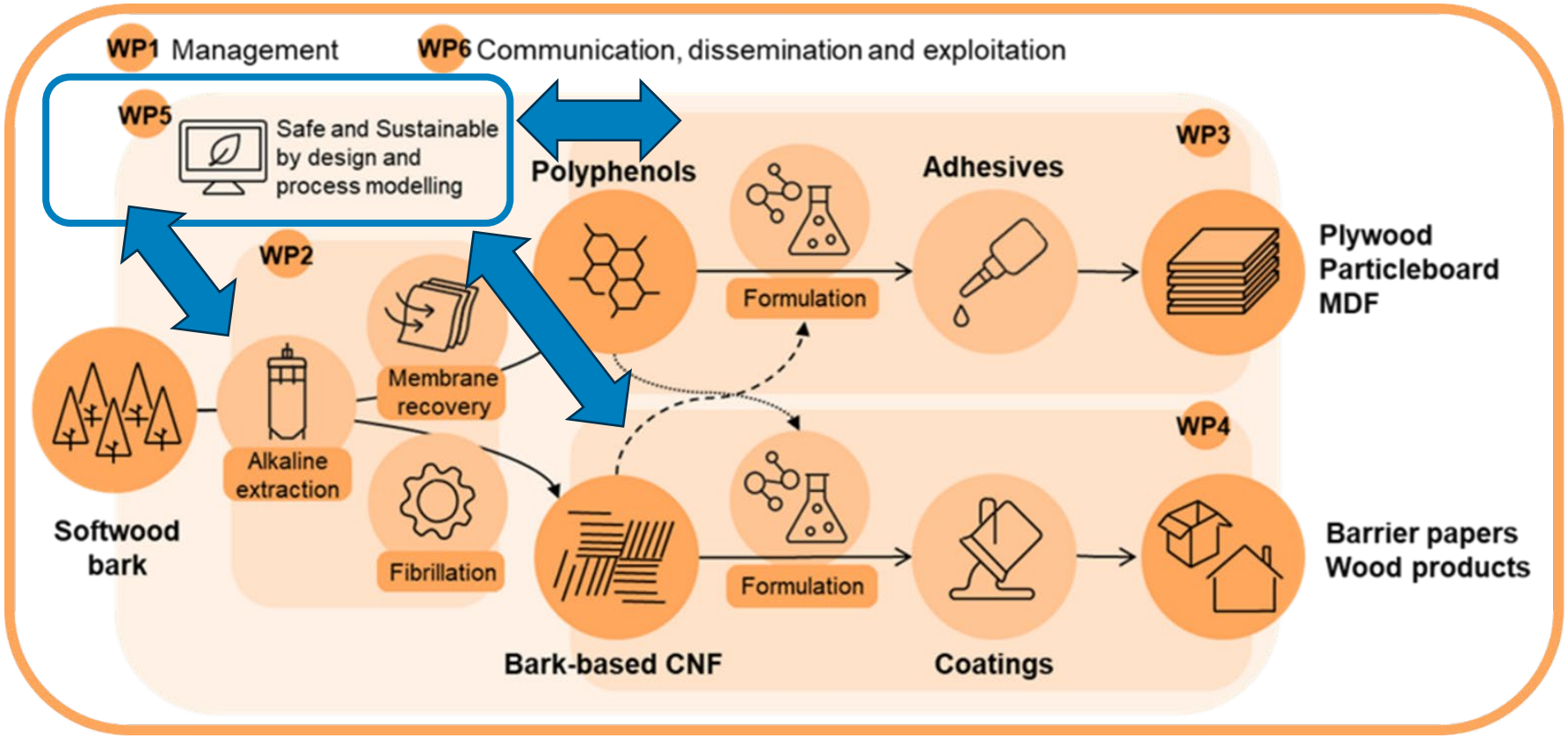
SSbD and SuperBark technological WPs

- Supportive WP
- Receiving and providing information to all technical WPs
- Adapting to the needs of technical partners
  - Identification of hotspots and input towards safer and more sustainable materials



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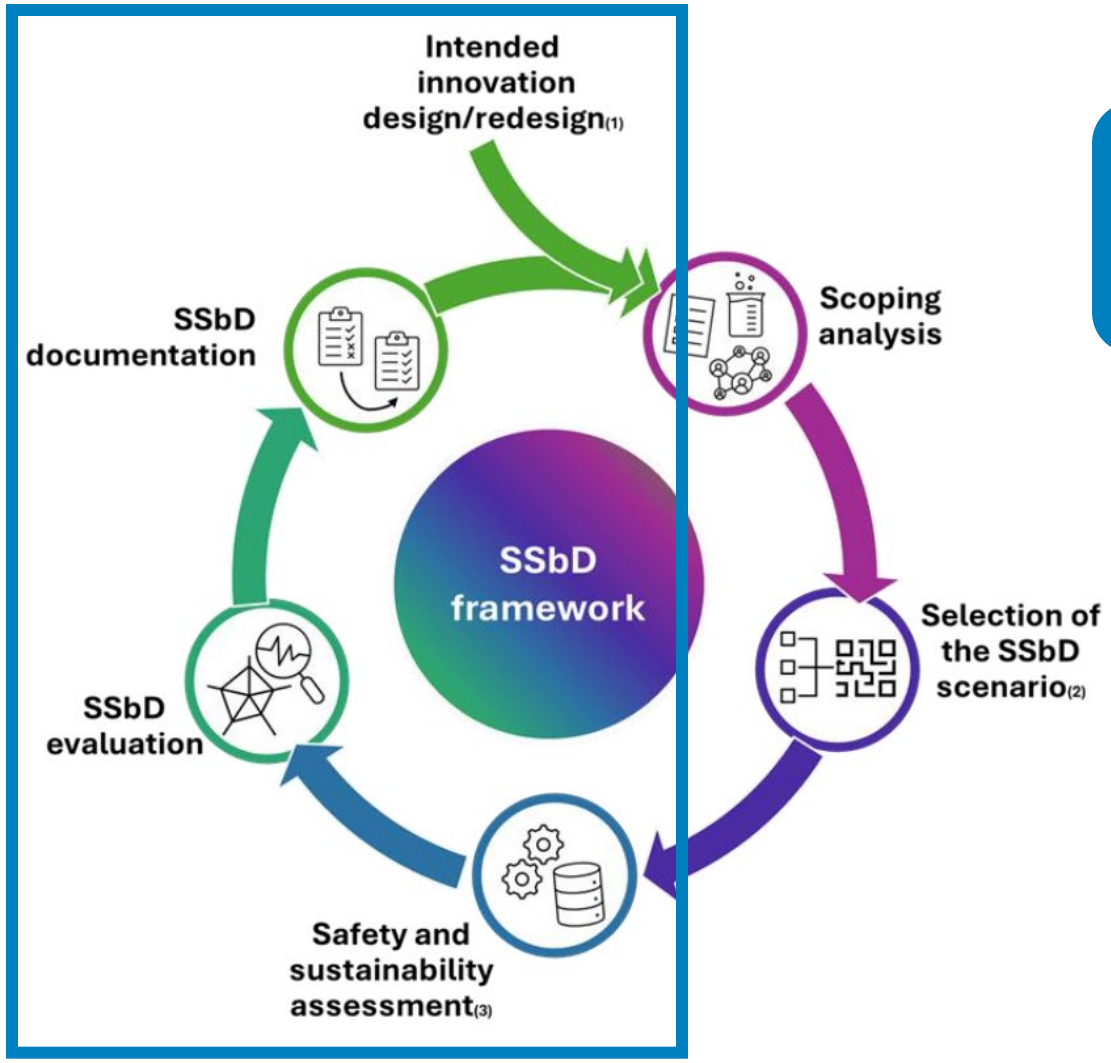
SSbD application SuperBark - Overview



SSbD assessment

- Safety and sustainability criteria

- Chemical safety assessment
- Environmental sustainability assessment
- Techno-economic assessment
- Recyclability
- Biodegradability

- Process workflows
- Safety screening / *In vitro*
- LCA
- TEA
- Biodegradability tests
- Recyclability tests
- System Dynamics modelling

Integration

*2025 SSbD framework revision

*SuperBark WP5 – Main activities

SSbD - Task overview

- **T5.1** SSbD Methodological Framework & Evaluation:
  - *Harmonized SSbD framework, system boundaries, data requirements, recommendations to technical WPs*
- **T5.2** Environmental Sustainability Assessment (LCA):
  - *Tiered approach, standardised LCA methodology (Simplified/Full)*
- **T5.3** Chemical Safety Assessment:
  - *Tiered approach, alternative methods, NAMs, in vitro experiments*
- **T5.4** Recyclability & Biodegradability:
  - *Wood adhesives/coatings, barrier papers, standardised methods*
- **T5.5** Technical, Economic & Market Evaluation:
  - *TEA and SD modelling*

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Setting the scene

- Apply EC SSbD framework to bio-based **adhesives** (plywood, MDF, particleboard) and **coatings** (wood & paper packaging)
- Replace fossil-based inputs: UF/PF adhesives → bio-based polyphenols & CNF; PFAS coatings → bio-based barrier
- Ensure safety & sustainability from TRL 3 to TRL 5 by project end

- Incorporate design principles in innovation stages (SSbD 1–8): material efficiency, hazard minimisation, energy efficiency, EoL design etc.
- Steps 1-3: Hazard assessment (REACH/CLP) → Worker safety → Consumer/env. Safety
- Step 4: LCA-based environmental sustainability (ISO 14040/44, PEF method, 16 impact categories)
- Step 5: Techno-economic assessment
- Iterative MCDA integration of all results

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Setting the scene

System boundaries defined for each sector (cradle to grave)

- Bioadhesives: NIPU adhesive, MDF adhesive, biohardeners for plywood, MDF and particleboards
- Biocoatings: Wood coatings, paper coatings

Functional units: **1 m³** engineered wood product; **1 m²** coated paper packaging

Reference scenarios defined, primary data collection, DBs for secondary collection (e.g., EcoInvent)

Colour-coded safety screening tool developed (red/yellow/green per hazard class)

Common **data collection template** for LCA & safety (flows, CAS numbers, costs, data quality)

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Main achievements

SSbD plan & data templates operational

- Safety
  - Safety hotspots – 2x iterative safety screening (ECHA Chem, Echem portal)
  - Identification of substances/materials for substitution (primary components, solvents, accelerators)
  - Comparison of alternatives
  - Focus on *in vitro* testing of new products (samples, endpoints, routes)

- Sustainability
  - Sustainability hotspots – Intermediate assessments
  - Identification of substances/materials for substitution (primary components, solvents, accelerators)
  - Comparison of alternatives (e.g., Harsh vs. Mild polyphenol extraction)
  - Alignment with Techno-Economic Assessment (TEA)
    - Scenario comparison / Assessment of environmental impacts of production scenario
    - Industrial partners scenario (Integrated vs stand-alone, CNF production and more)

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Main achievements

- TEA
  - Different scenarios assessed
    - Polyphenol recovery & use / Integration / adhesive & CNF production
    - Estimations of Operational Costs and Total Production costs for each scenario
    - Cross comparisons / Assumptions

- System Dynamics modelling
  - Identification of criteria (softwood/hardwood, compositions)
  - Stakeholder groups identification (internal, external)
  - Mathematical modelling to visualise inter-dependencies

- Recyclability testing and Biodegradability - Initial considerations
  - Recyclability: CEPI method for paper, shredding/reuse for MDF
  - Biodegradability: Initial assessment of coated paper (ISO 14855-1)
  - Recyclable and biodegradable coated papers
  - Identify issues in early innovation stages

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Challenges / Open questions

- Availability of data
  - Component composition
  - Scale-up/pilot data
  - Synchronisation of SSbD with innovation speed
- Inherent uncertainties on the integration of results
  - Trade-offs
  - Data gaps
  - Integrate safety, sustainability and EoL considerations in a predictive/meaningful way

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Super Bark

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Thank you!

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