

More value from less harvest: the future of biomass cascade processing for novel biohybrid and added value products of circular bioeconomy

Tuula Jyske

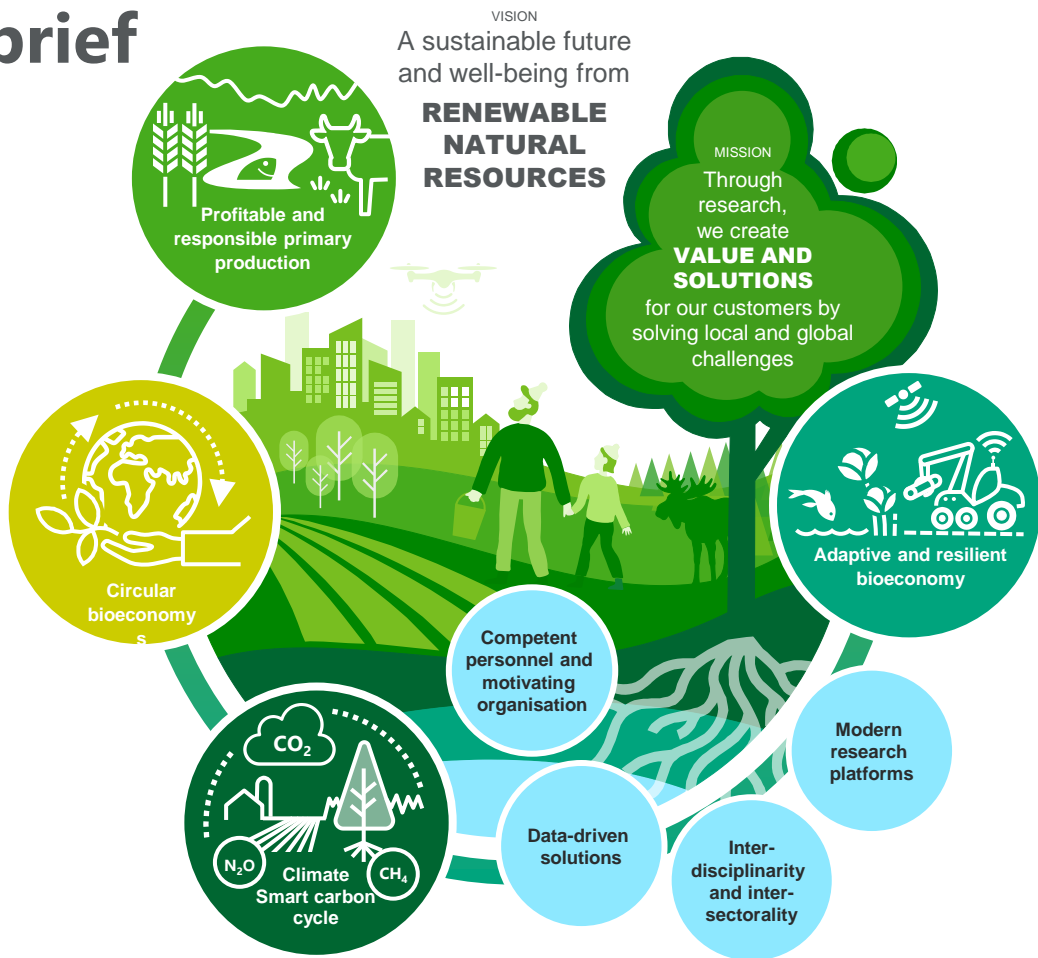
Natural Resources Institute Finland

&

University of Helsinki (since 1 Jan 2023)



Luke in brief



129 M€

Turnover

75 M€

Budget funding

54 M€

External funding*

22

Locations in Finland

HQ in Helsinki

Present in 12 campuses with universities, research institutes and polytechnics

1274

Employees

14 Management

44 Research professors

603 Researchers

613 Other specialists

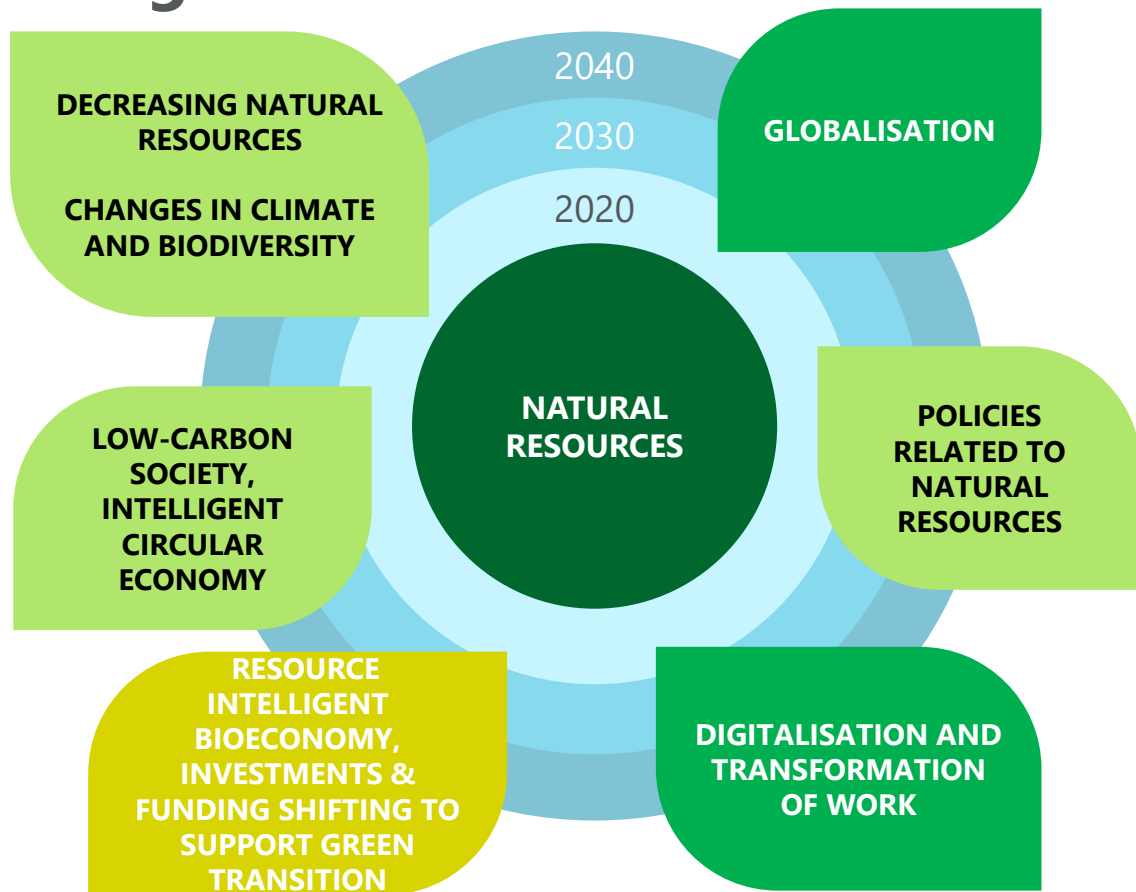
* Includes profits from co-funded, collaboration and customer-funded projects and other income. Information from the year 2020.

Changes in the operating environment

There are many expectations and demands for the forest resources:

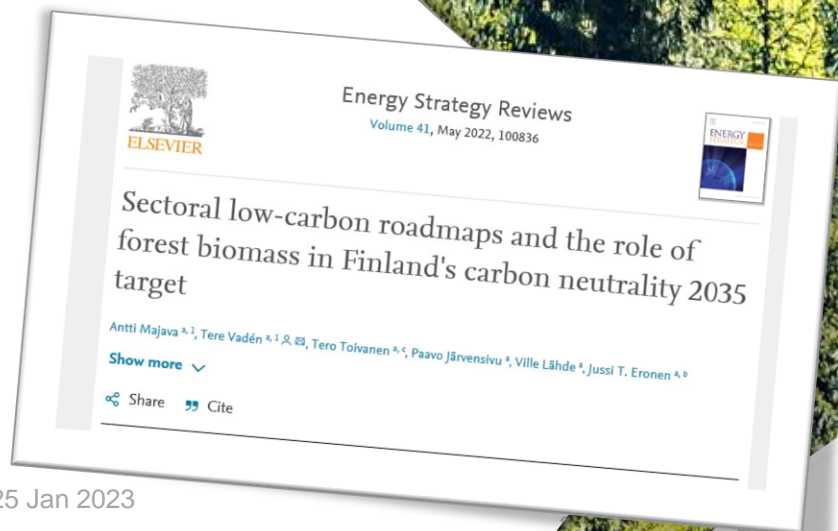
→ not everything can be fully met, but

→ **science-based knowledge & data enable holistically sustainable decisions**



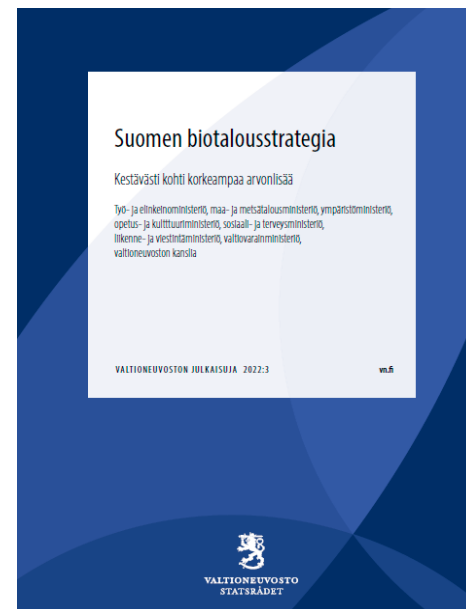
Carbon negative targets by 2035

- BIOS article:
 - low-carbon roadmaps require 140 Mm³ of biomass
- In terms of wood production, the highest level of fellings that can be maintained is approx. 80 Mm³
- What else?
 - Frugality
 - Less is more
 - Recyclability
 - Changeability
 - Longevity
 - Sidestream & waste-based solutions

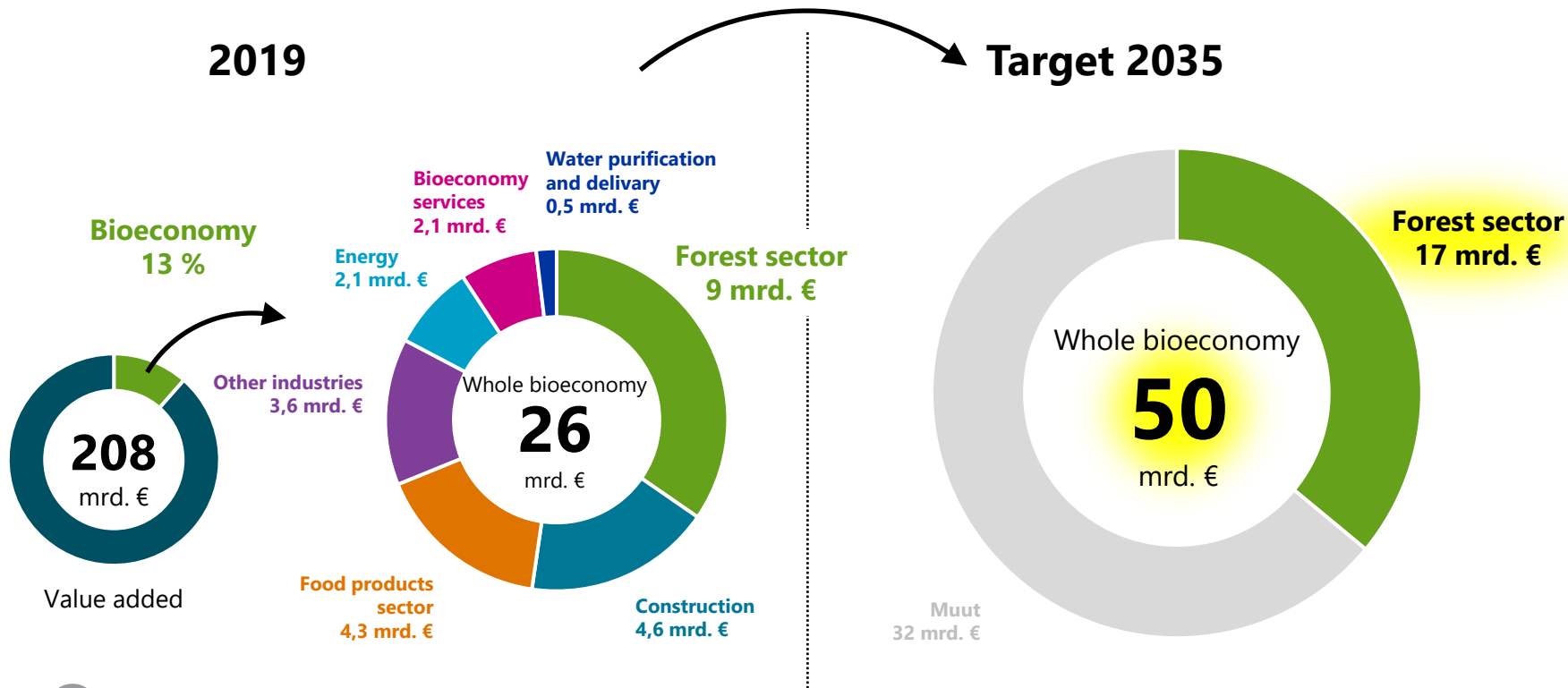


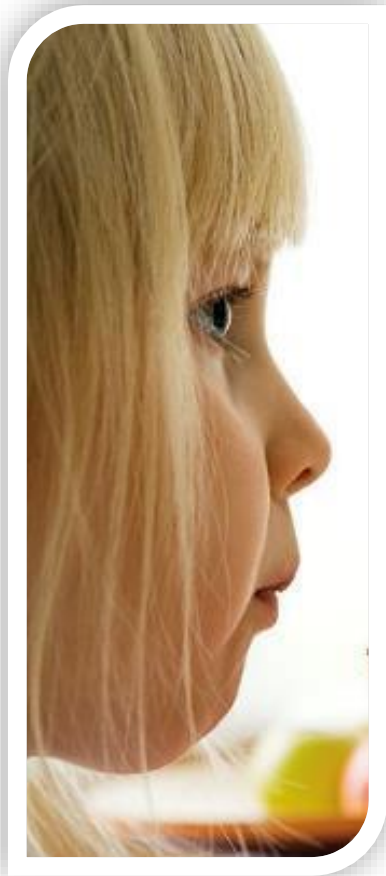
Bioeconomy strategy targets by 2035

- The main goal of the strategy is to increase the **added value** of the bioeconomy
- The goal is to create **economic growth** and **jobs** based on sustainable solutions by producing **products and services with the highest possible added value**
- The **value added** of the bioeconomy was **26 billion euros in 2019**. The goal is that the value added of the bioeconomy in **2035** will be **50 billion euros**.
- The strategy does not argue on the amount of production but strives to produce an even higher added value.



The target of the forest sector in 2035



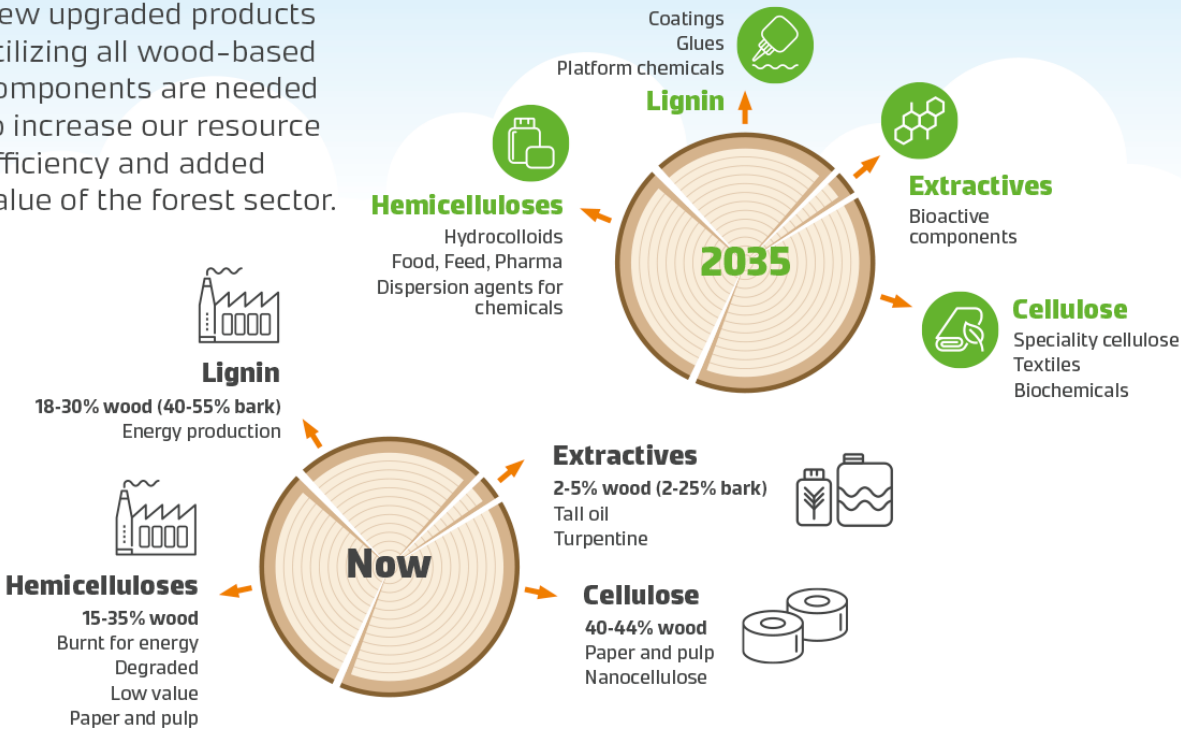


Need for new supply of biomass and rethinking of sustainable value-chains for bioproducts – the rapidly changing world challenges the security of supply

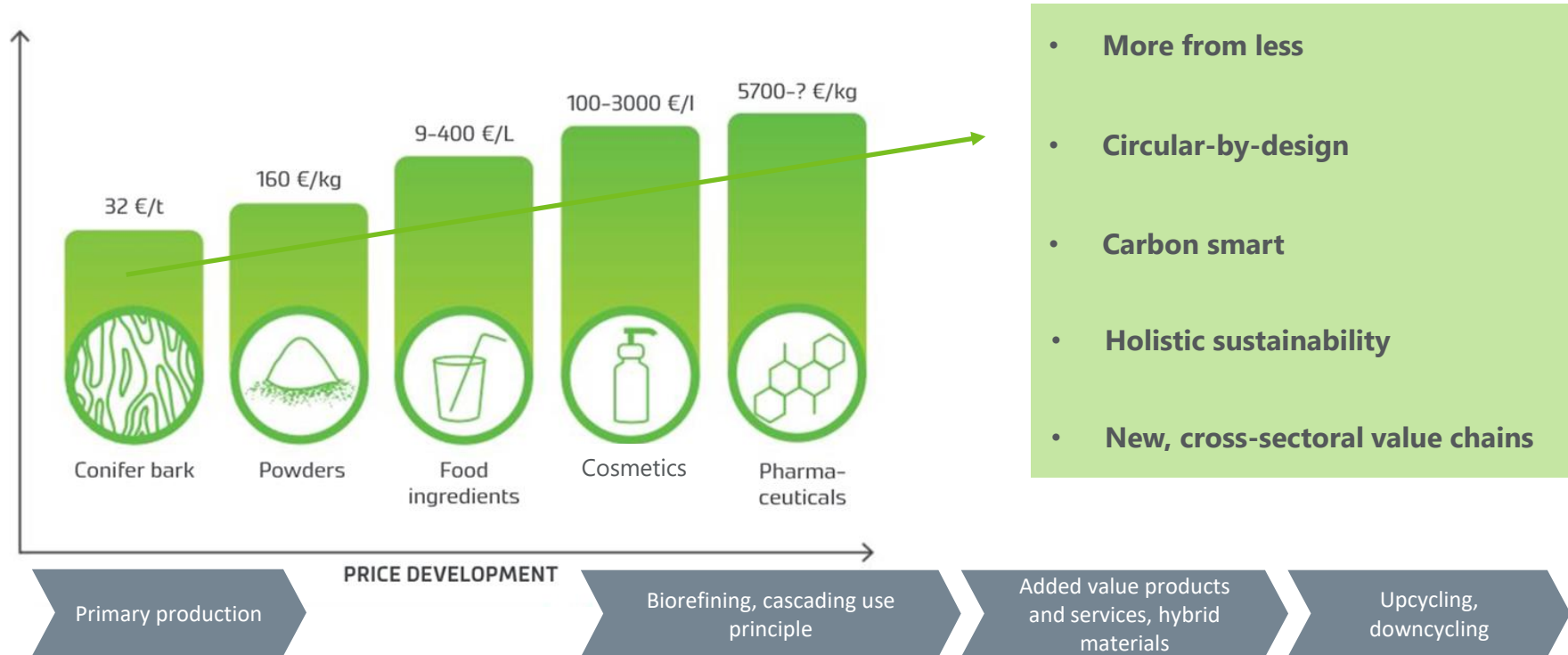


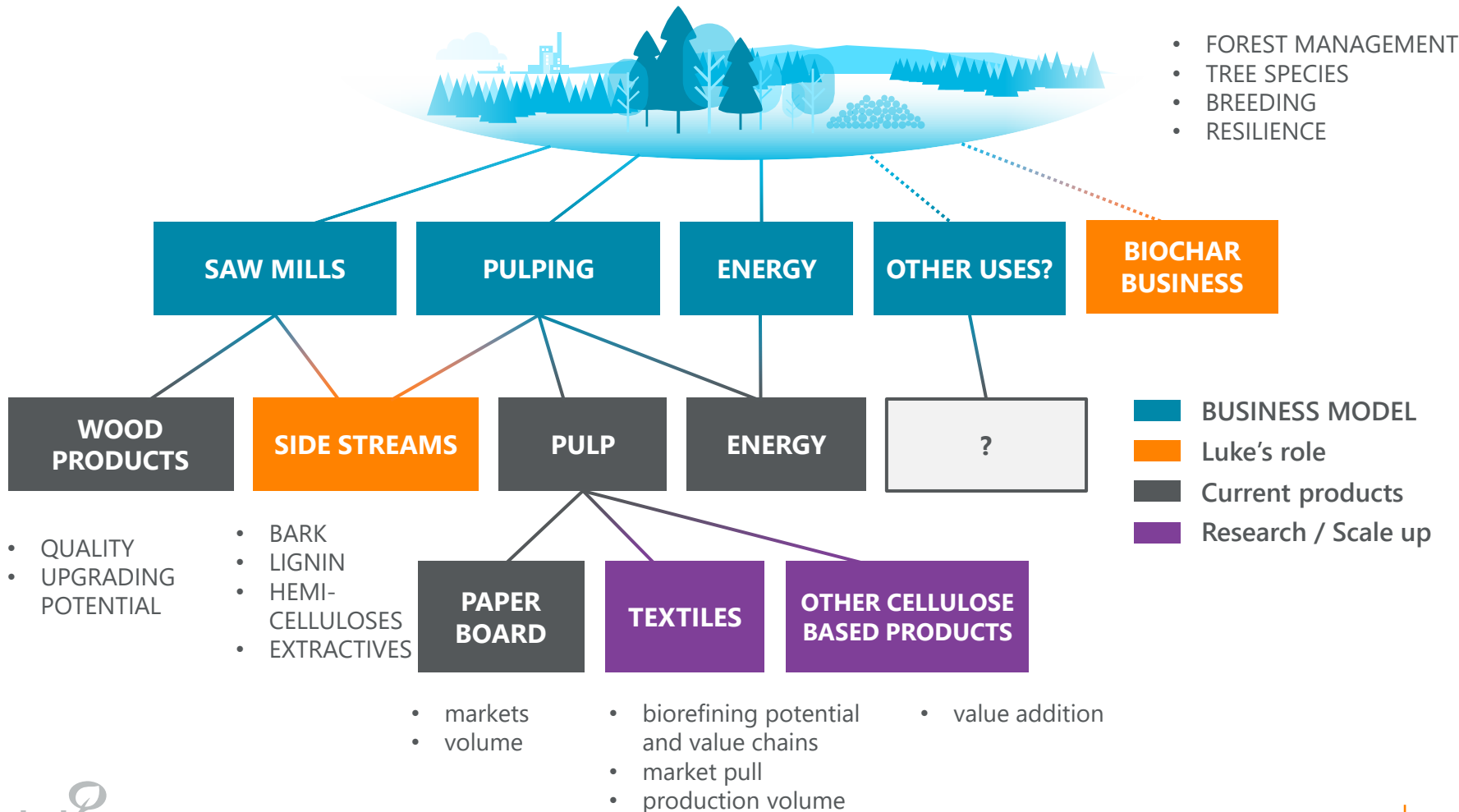
Comprehensive use of wood biomass

New upgraded products utilizing all wood-based components are needed to increase our resource efficiency and added value of the forest sector.

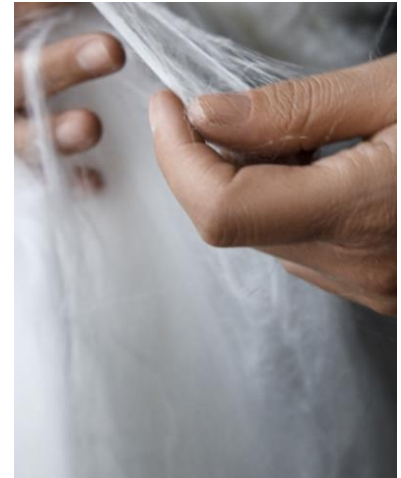
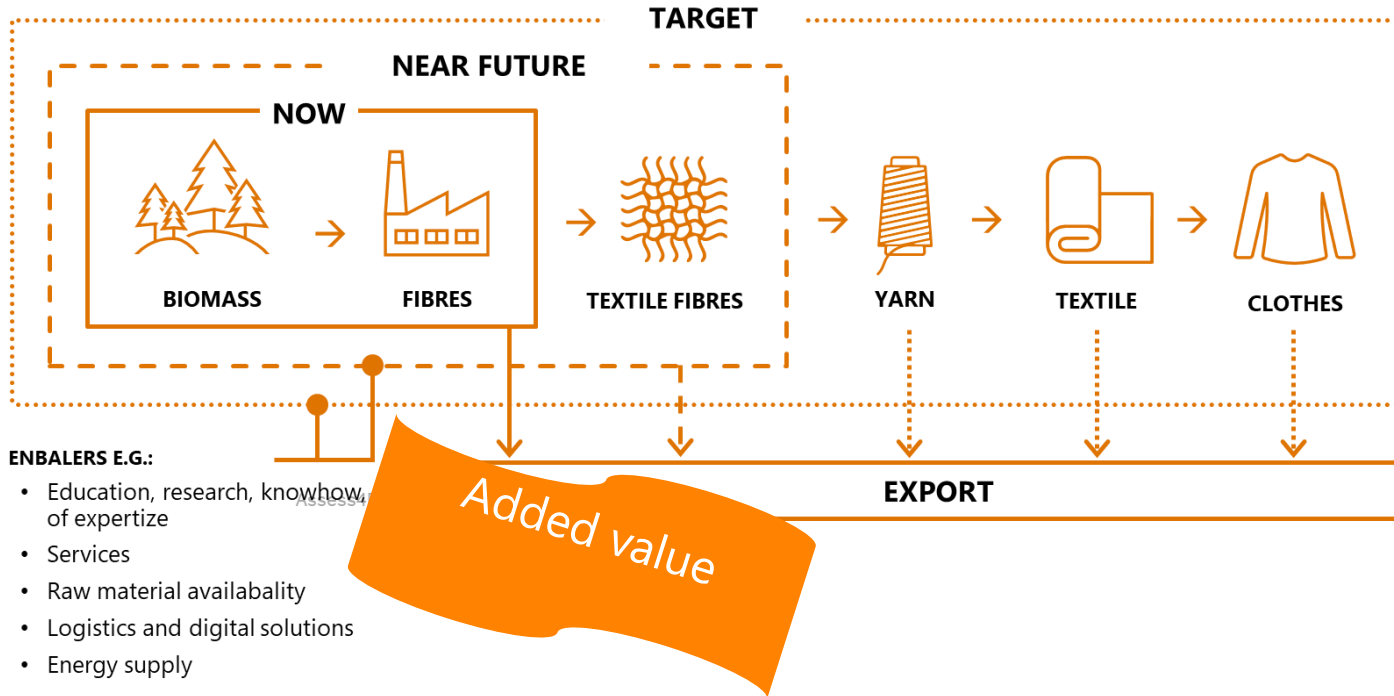


Research towards high added value products, services, and business



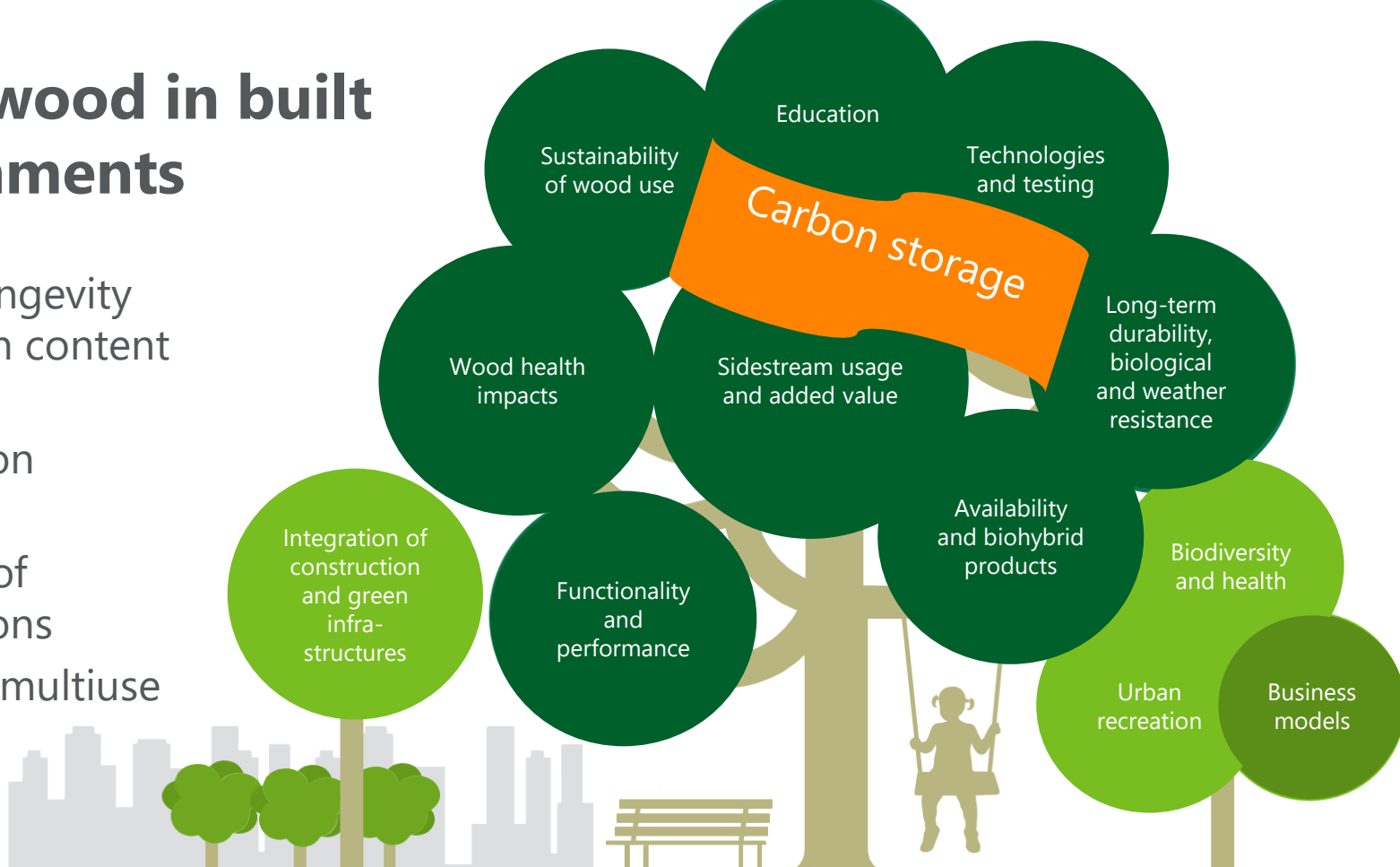


Upgrading cellulose: wood-based textile value-chain

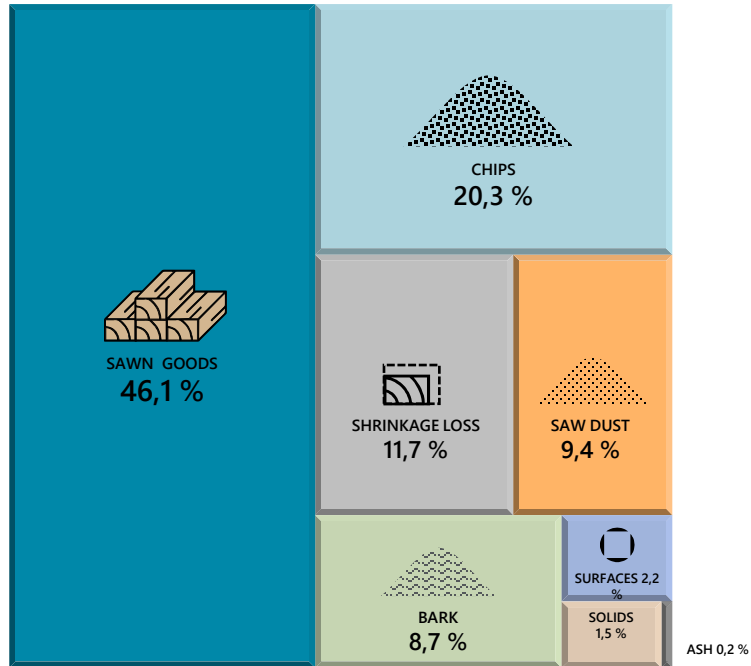
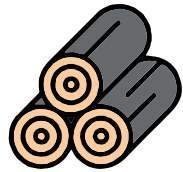


Use of wood in built environments

- Product longevity and carbon content
- Industrial construction concepts
- Repairing of constructions
- Modular / multiuse buildings



Saw milling side streams



**Hemicelluloses
as
hydrocolloids
for food and
feed products**

**Added
value
chemicals**

Hassan, M.K., Villa, A., Kuittinen, S. *et al.* An assessment of side-stream generation from Finnish forest industry. *J Mater Cycles Waste Manag* **21**, 265–280 (2019). <https://doi.org/10.1007/s10163-018-0787-5n>

Visioning across (sectoral) boundaries

The cross-sectoral production chains:

- a great **opportunity for the new business**
- but **bottlenecks** in building of new networks and chains of actors

Biohybrid materials

Unconventional uses



Biohybrid products for (re)construction

BF Co-innovation building on the way (PI: Marja Lehto)

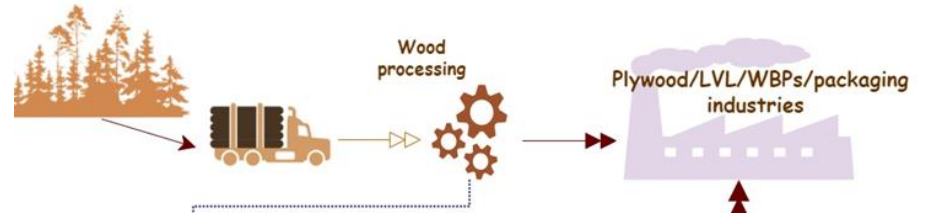
FEATHERPRODUCT

Products from chicken feathers and other less utilized raw materials

Marja Lehto, Heidi Högel, Juhani Marttila, Panu Miettinen, Henrik Heräjärvi



Crushed whole and crushed chicken feathers, turtle waste and wood shavings.



Biobased adhesive system R-to-B, TRL 5, patenting on the way (PI: Anuj Kumar)

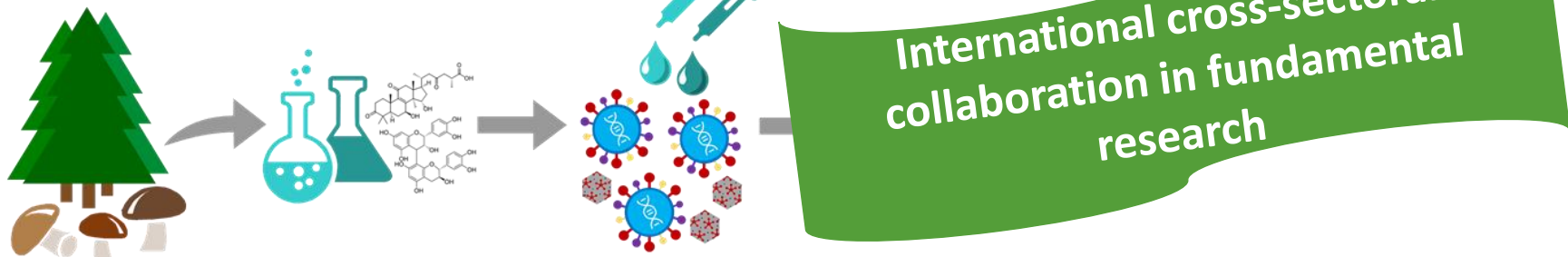
Functional material solutions from Finnish forests

Antivirals from forest biomass: structure, function, and applicability

09/2021 – 08/2025

Consortium PI Tuula Jyske, Luke team: Petri Kilpeläinen, Jaana Liimatainen, Jenni Tienaho, Riikka Linnakoski, Hanna Brännström

Sub-project leader Varpu Marjomäki, JYU



What are the antiviral mechanisms and structure-activity -relations of antiviral and antimicrobial extracts and preparations of bark and fungal biomass?

WP 1: Optimizing methods to obtain antiviral & antimicrobial fractions
Luke, mob. Italy, JYU

WP 2: Chemical characterization & structure-activity interlinkages
Luke, mob. UTU, mob. USA, JYU

WP 3: Identification of antiviral mechanisms
JYU, collab. SA, France, Luke, mob. SA

WP 4: Activity maintenance & optimization when immobilized
JYU, mob. collab. SA, Luke

Figure 1. The *ForestAntivirals* research premise, WPs, roles of partners, collaboration (collab.), and mobility (mob.) in Italy, the University of Turku (UTU) in Finland, the USA, France, and South Africa (SA).



Development of **bio-based materials** for driving towards sustainable **facemask** production and reduced environmental impact (BIOPROT)

Luke and JYU role:

- Novel **antiviral coatings** for face masks and other material surfaces **from the raw materials of Nordic woods**



Applied research to support business & export



Legend for the circular diagram:
Yellow square: Research organization partners
Green square: In-kind Partners
Blue square: Sub project industry partners



Luke coordinator: Tuula Jyske
JYU WP leader: Varpu Marjomäki

StAB Circular Bioeconomy, June 2022



Natural Antiviral Ingredient

Currently, there are no effective solutions against viruses

We offer fully bio-based solutions that stops virus' infection

New market opportunities in cosmetics and sustainable disinfection industry

Offers alternative for traditional disinfection and functional



PulPaper Award kunniamaininnan saanut Natural Antivirals/Riikka Linnakoski ja voittaja Montinutra/Jaakko Pajunen

Alternative for disinfection solutions

Protects broadly against viruses

Skin conditioning

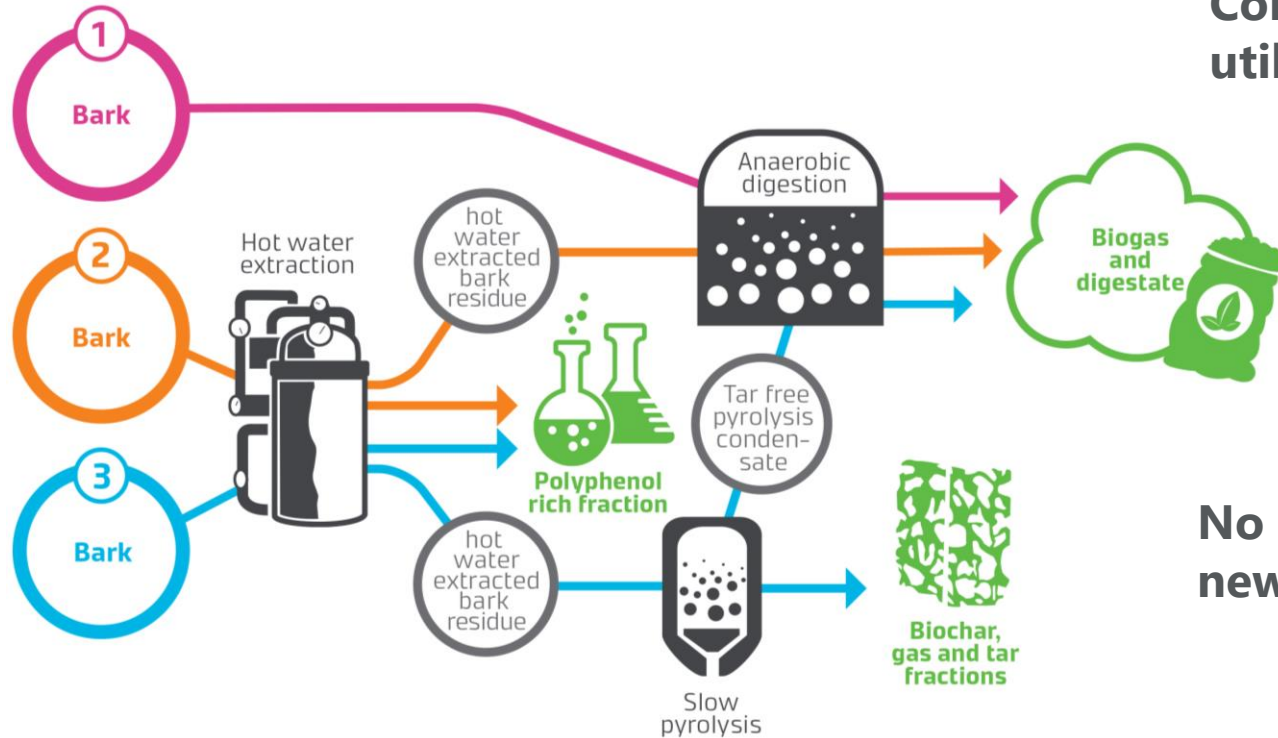
bio-based

Vegan



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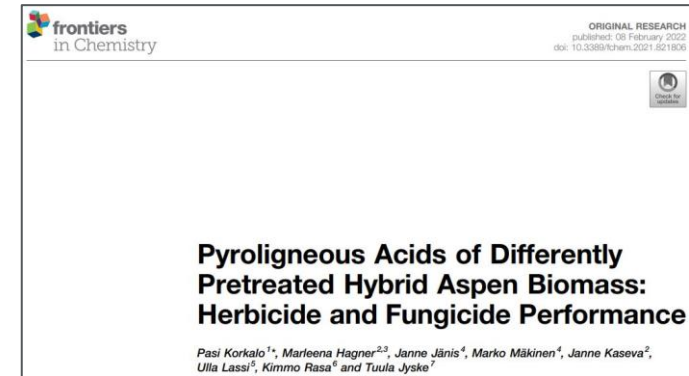
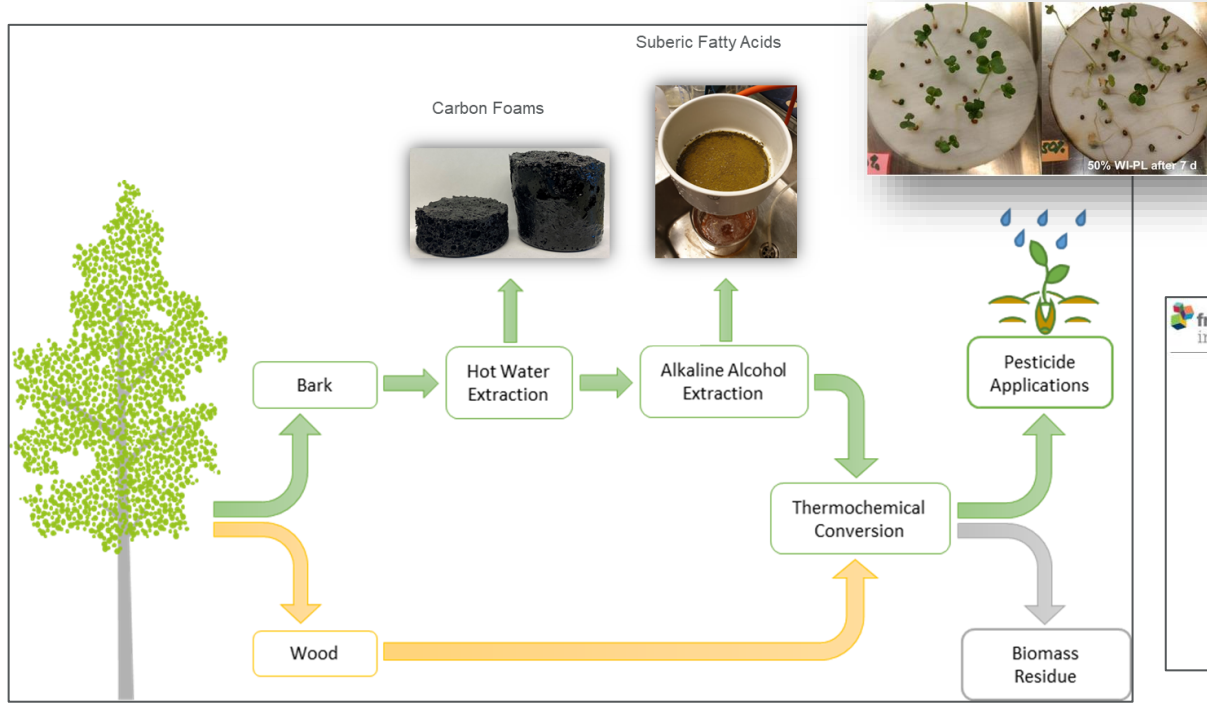
Cascade processing of biomasses



Comprehensive utilization

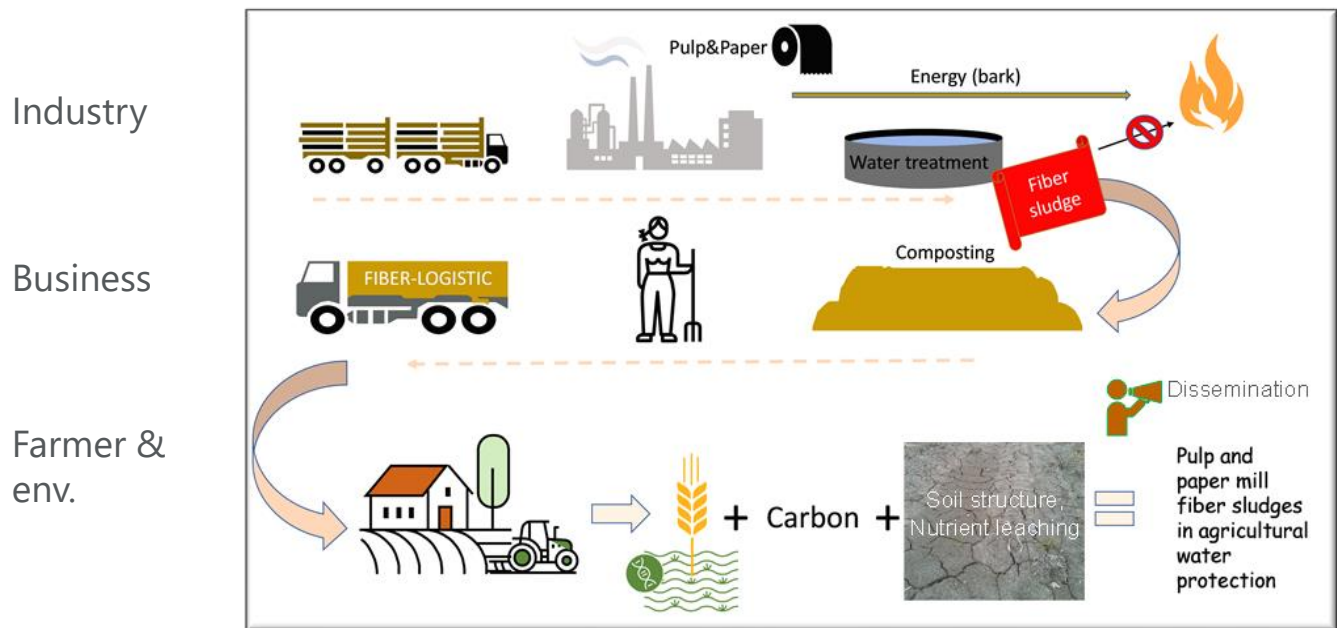
No generation of new waste streams

Circularity: forestry side-streams to plant protection



Circularity: fiber sludge from forest industry to farms

Fiber sludge, from side-stream to new product



Contact: Kimmo Rasa, kimmo.rasa@luke.fi

Food- & feed ingredients from forestry side-products



Article

Sprouts and Needles of Norway Spruce (*Picea abies* (L.) Karst.) as Nordic Specialty—Consumer Acceptance, Stability of Nutrients, and Bioactivities during Storage

Tuula Jyske^{1,*}, Eila Järvenpää², Susan Kunnas¹, Tytti Sarjala³, Jan-Erik Raitanen^{1,4}, Maarit Mäki², Helena Pastell⁵, Risto Korpinen¹, Janne Kaseva² and Tuomo Tupasela²

Biomass Conversion and Biorefinery
<https://doi.org/10.1007/s13399-022-02624-9>

ORIGINAL ARTICLE



Stilbenoids of Norway spruce bark: does the variability caused by raw-material processing offset the biological variability?

Tuula Jyske¹, Hanna Brännström², Eelis Halmemies², Tapio Laakso¹, Petri Kilpeläinen¹, Juha Hyvönen³, Katri Kärkkäinen⁴, Pekka Saranpää¹

Received: 26 January 2022 / Revised: 17 March 2022 / Accepted: 18 March 2022
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Article

Tannins of Conifer Bark as Nordic Piquancy—Sustainable Preservative and Aroma?

Jan-Erik Raitanen^{1,2}, Eila Järvenpää³, Risto Korpinen¹, Sari Mäkinen³, Jarkko Hellström³, Petri Kilpeläinen¹, Jaana Liimatainen¹, Ari Ora¹, Tuomo Tupasela³ and Tuula Jyske^{1,*}

European Food Research and Technology (2019) 245:1387–1398
<https://doi.org/10.1007/s00217-019-03273-5>

ORIGINAL PAPER

Spruce galactoglucomannan-stabilized emulsions as essential fatty acid delivery systems for functionalized drinkable yogurt and oat-based beverage

Fabio Valoppi^{1,2}, Ndegwa Maina¹, Marja Allén¹, Roberta Miglioli^{1,3}, Petri O. Kilpeläinen⁴, Kirsi S. Mikkonen^{1,2}



Food Chemistry: X
Volume 5, 30 March 2020, 100074



Active food packaging through controlled *in situ* production and release of hexanal

Mari Lehtonen^{a,1}, Sonja Kekäläinen^a, Ida Nikkilä^a, Petri Kilpeläinen^b, Maija Tenkanen^{a,c}, Kirsi S. Mikkonen^{a,c}



Food and Chemical Toxicology
Volume 153, July 2021, 112284



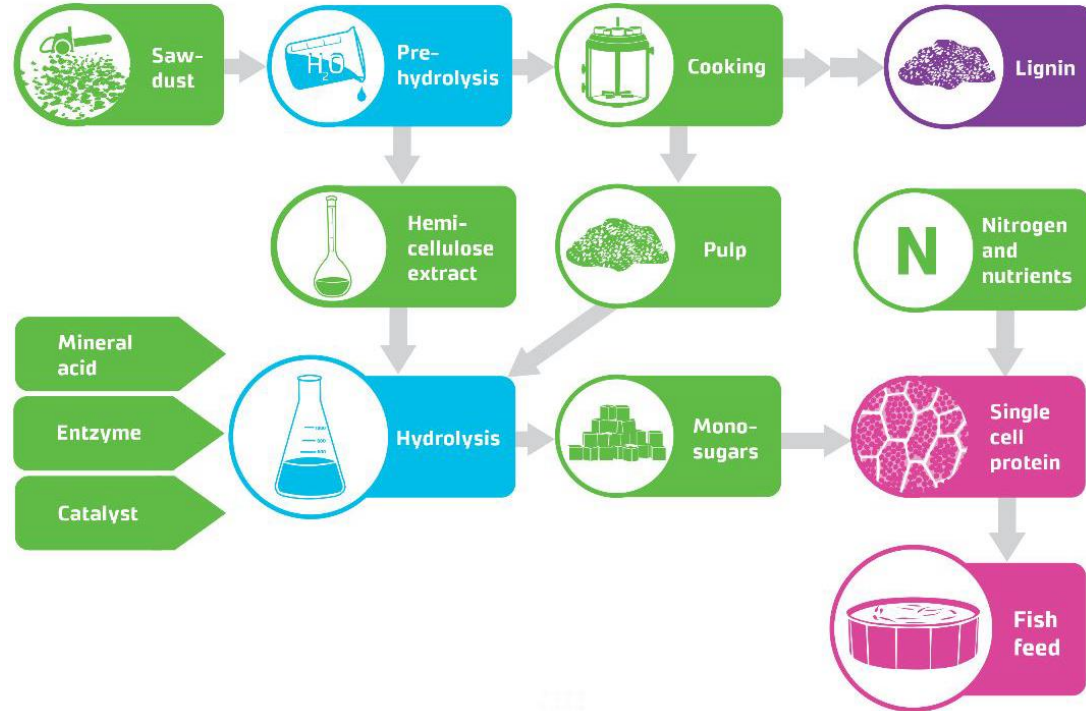
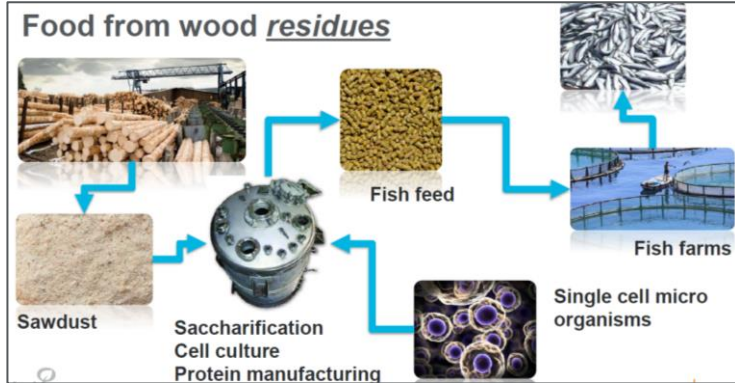
Toxicological and bioactivity evaluation of blackcurrant press cake, sea buckthorn leaves and bark from Scots pine and Norway spruce extracts under a green integrated approach

Nora Pap^a, Dhanik Reshamwala^b, Risto Korpinen^c, Petri Kilpeläinen^c, Marina Fidelis^d, Marianna M. Furtado^e, Anderson S. Sant'Ana^e, Mingshun Wen^f, Liang Zhang^f, Jarkko Hellström^g, Pertti Marrilla^g, Piijo Mattila^h, Tytti Sarjala^h, Baoru Yangⁱ, Amanda dos Santos Lima^j, Luciana Azevedo^j, Varpu Marjomäki^b, Daniel Granato^k

https://www.youtube.com/watch?v=Qs5nFp8_iEs&feature=emb_title

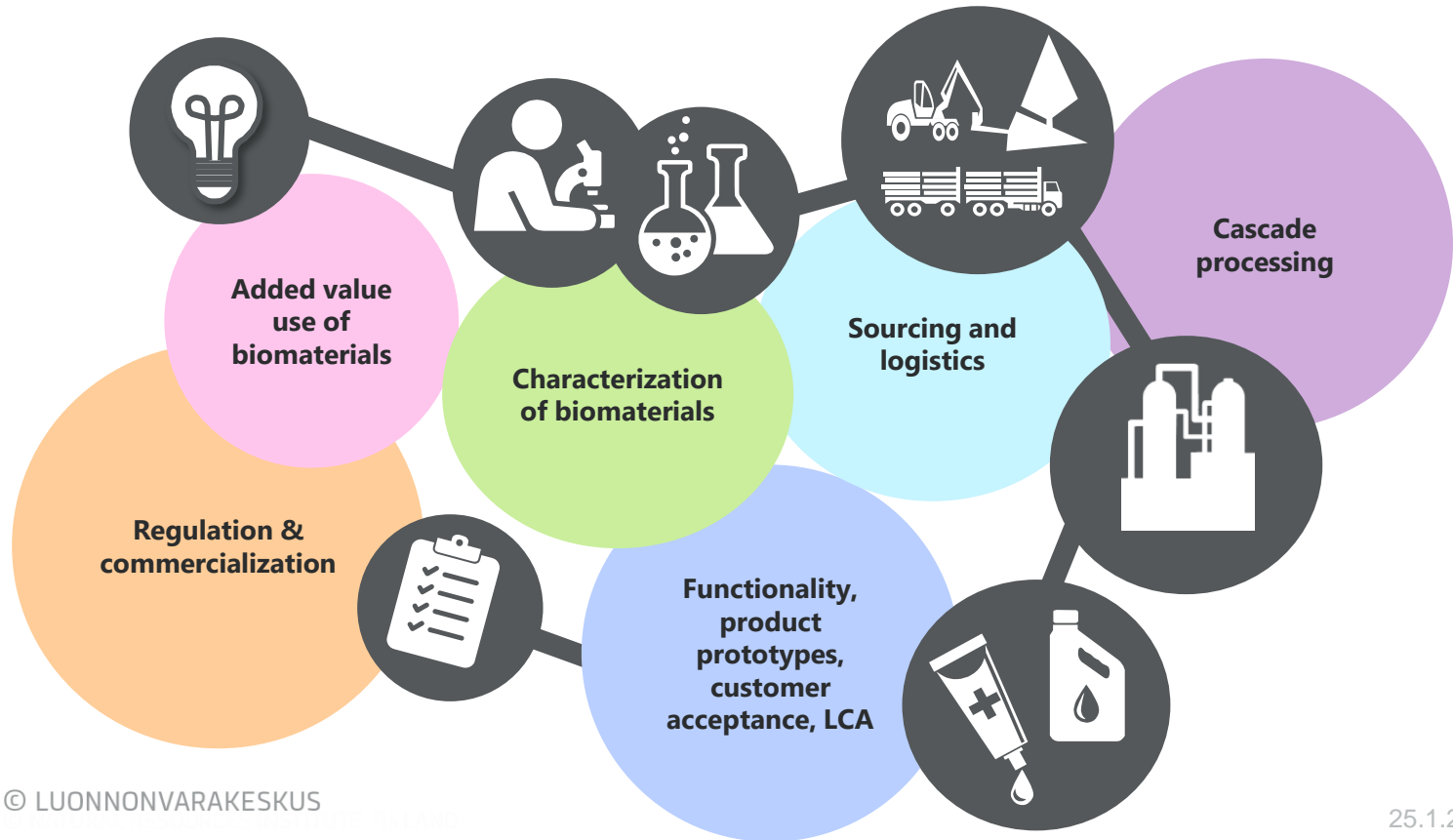
Hokkaido Finland Week – Forestry Day 2022

Luke MonoCell -process



Contact: Risto Korpinen, risto.korpinen@luke.fi

Knowledge and research across value chains



Co-creation, customer services, data and tools



CO-CREATION!

CO-INNOVATION!

Summary

- Not all expectations related to biomass can be fully met
- The wood to be used as comprehensively as possible, to be used multiple times (cascade use): **less is more, more from less**
- Biomass to be used for essential goods – what are they?
Also: consumption reduction.
- Self-sufficiency and security of supply:
 - Side streams to be processed into added value components with the latest technologies,
 - New opportunities in value chains that cross industry boundaries.



