Forest-Based Biorefineries: The Pulp and Paper Industry.

A contribution to the National Bioeconomy Roadmap

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The Portuguese Forest Industries - Exports

Forest: 35% of Portuguese territory
Forest-based industries represent 9.4% of Portuguese Exports
2015, 49,816 M€

% Total exports

Wood: 1.3%
Cork: 1.8%
Pulp & Paper: 5.0%
Furniture: 1.3%
Total: 9.4%

% Pulp & Paper exports on Portuguese Forest-based industries: 53%

Source: INE

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Today pulp & paper mills

- Wood
- Fibres
- Chemicals
- Biomass residues

Chemicals & energy recovery (combustion)

- Solid residues
- Heat and electricity
- UWF Paper
- Tissue
- Market pulp

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The Portuguese eucalyptus based pulp & paper industry

- Wood consumption: 8-9 M m³ (4-5 M dry ton)
- Pulp production: 2.2 M dry ton (partly converted into paper)
  - => ~2 M dry ton wood by-products in pulping process (“black liquors”, nowadays burned for chemicals recovery, thermal and electric energy production)

Harvesting, logging, debarking and chipping generates up to 1 M dry ton of forest biomass by-products

- bark
- tops
- branches
- sawdust

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Tomorrow pulp & paper biorefineries

Fibres
Chemicals
Wood
Biomass residues

Chemicals & energy recovery (combustion)

Biomass deconstruction & separation processes

Pulping By-products

Cellulose
Hemicelluloses
Sugars
Lignin
Extractives

Bioproducts
Biochemicals
Biofuels

Up-graded residues
Solid residues
Heat and electricity
UWF Paper
Tissue
Market pulp
New fibre-based products
Lignin

Market pulp
Up-graded residues

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Biochemicals from biomass extractives

Essential oils

For fragrances, cosmetics and pharmaceutical products, a 1.5 billion € market
Nanocellulose for paper coating and food additives

Global Nanocellulose production capacities estimates for 2020

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Cellulose-based biocomposites

Injection Molding

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Lignin-based products

Vanillin and syringaldehyde

Vanillin and syringaldehyde obtained (2.5%) by eucalyptus globulus lignin oxidation

Lignin polyols

Lignin-based foams for thermo insulation

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Sugar-based products

Enzymatic hydrolysis – scale up

5 L beakers - RAIZ
50 L reactor - LNEG

Sugar syrups

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Sugar-based products

Plattform chemicals from sugars
Bioethanol: a worldwide growing market
Cellulosic bioethanol is emerging: ≈ 17 billion L in 2022, 10% share
Sugar-based products

Bacterial cellulose from wood/cellulose sugars

Wood fibers
~20-40 μm width, ~1-3(+) mm length

Bacterial cellulose (*Gluconacetobacter*)
Nanofibrils 10-100 nm width, 3D network

Food additives
Cosmetics

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The inpactus project

Promoter

Co-Promoters

Partners

180 Researchers and technitians
50 Research scholarships
17 PhD students
PhD programme on Biorefineries (UA, UC)
2 International invited chairs

Total Funding: 15 M€ (2018-2022), Public Funding: 8,6 M€
Forest-based bioeconomy roadmap

• Forestry and forest-based industries – key players of portuguese bioeconomy
• Dynamic, innovative and exporting industry – potential for business diversification, bioproducts
• But ... risk of scarcity of of wood and forest biomass in the future
• Excellent R&D competences and facilities (universities, RTOs, Companies)
• New supporting instruments and initiatives, not integrated ... or sharing the same vision
  Biorefineries National Plan (PNPB), National decarbonization roadmap, Collaborative Laboratories ...

• **A Bioeconomy National Roadmap required!**
  • Clear policy (priorization!) with clear milestones and KPIs
  • Integrating and boosting existing / ongoing instruments and initiatives
  • Promoting the three sustainability pillars: economic, environmental, social
  • Giving absolute priority to territory land-use organization and planning;
    • forest management: productivity, resilience, sustainability; plantation and preservation forests
    • development of the inner regions of the country
  • Promoting innovation and knowledge transfer from universities to primary sector and business
    • Adequate balance between fundamental (but focused!), applied science and innovation
    • Covering the main industrial wood species
    • New products, new markets
  • Promoting bio-based entrepreneurship (from primary sector to new bio-based businesses)
  • Promoting the evolution of forest based industries to modern biorefineries
  • Promoting qualification of human resources: forestry and forest-based processes and products
Obrigado!