

Building Bridges between Forestry & Chemistry

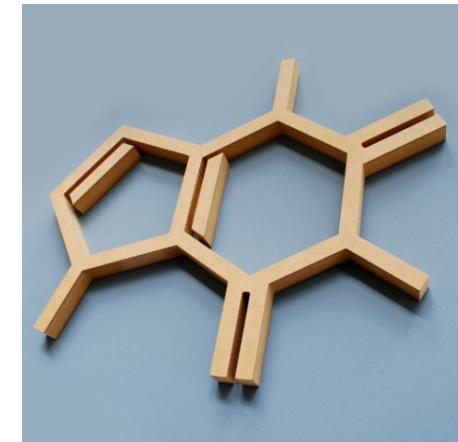
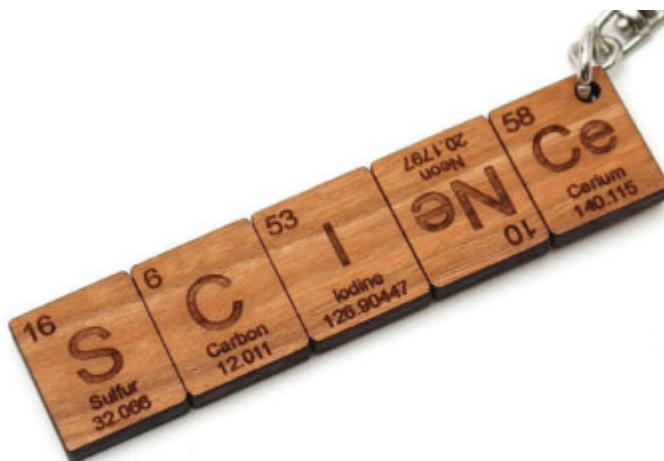
Support European Bio-Economy Programs



Pascal XANTHOPOULOS
Director PolyBridge®
Partner Pôle de Compétitivité XYLOFUTUR

AgroBiotech Innovation Event
Ourense, November 26-27th, 2015

Re-Invent Wood Chemistry, Innovate for All



Goethe

« *Knowing is not enough, we must apply; Willing is not enough, we must do..* »



This SAWMILL processes 220 000 tons WOOD logs to manufacture 120 000 m³ of timber



**...but also ca. 100 000 tons of BY-PRODUCTS → 50% YIELD !
barks, sawdust, wood chips, knots ...**



Current Valorisation of Wood BY-PRODUCTS by Sawmills



Dowsntream Trends for the current Routes of Valorisation





**What about a more added value valorisation of wood by-products
Based on the
development of wood chemicals ?**



1 100 000 tons wood biomass are processed to produce 300 000 tons of Pulp

...but also ca. 500 000 tons of BY-PRODUCTS
barks, sawdust, knots ,liquors...



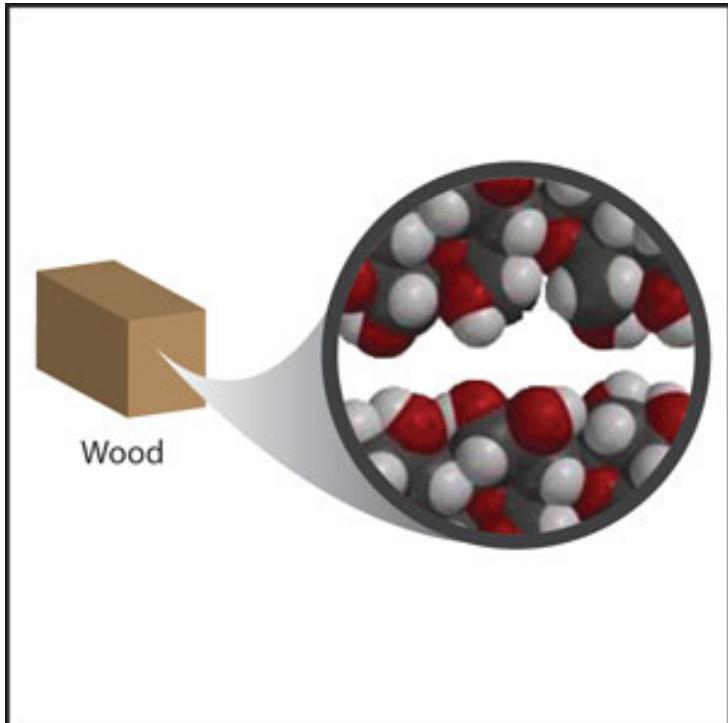


Current Valorisation of Wood By-Products by Paper Mills



Dowsntream Trends for the current Valorisation Routes

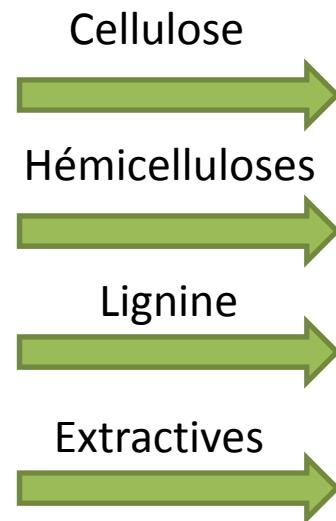




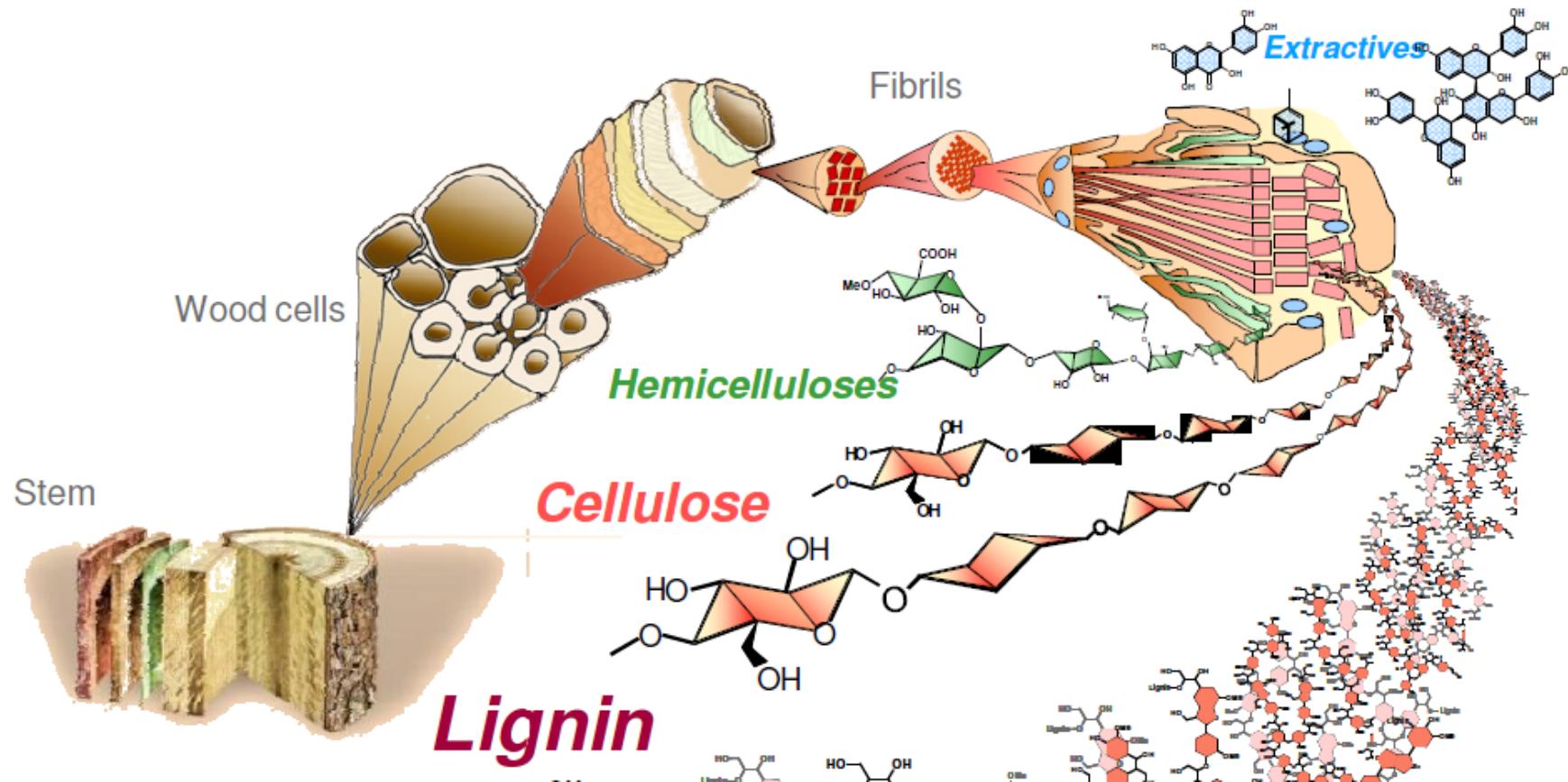
**What about a more added value valorisation of wood by-products
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Valorization wood byproducts

Our motto: « Extract the Best, Burn the Rest »

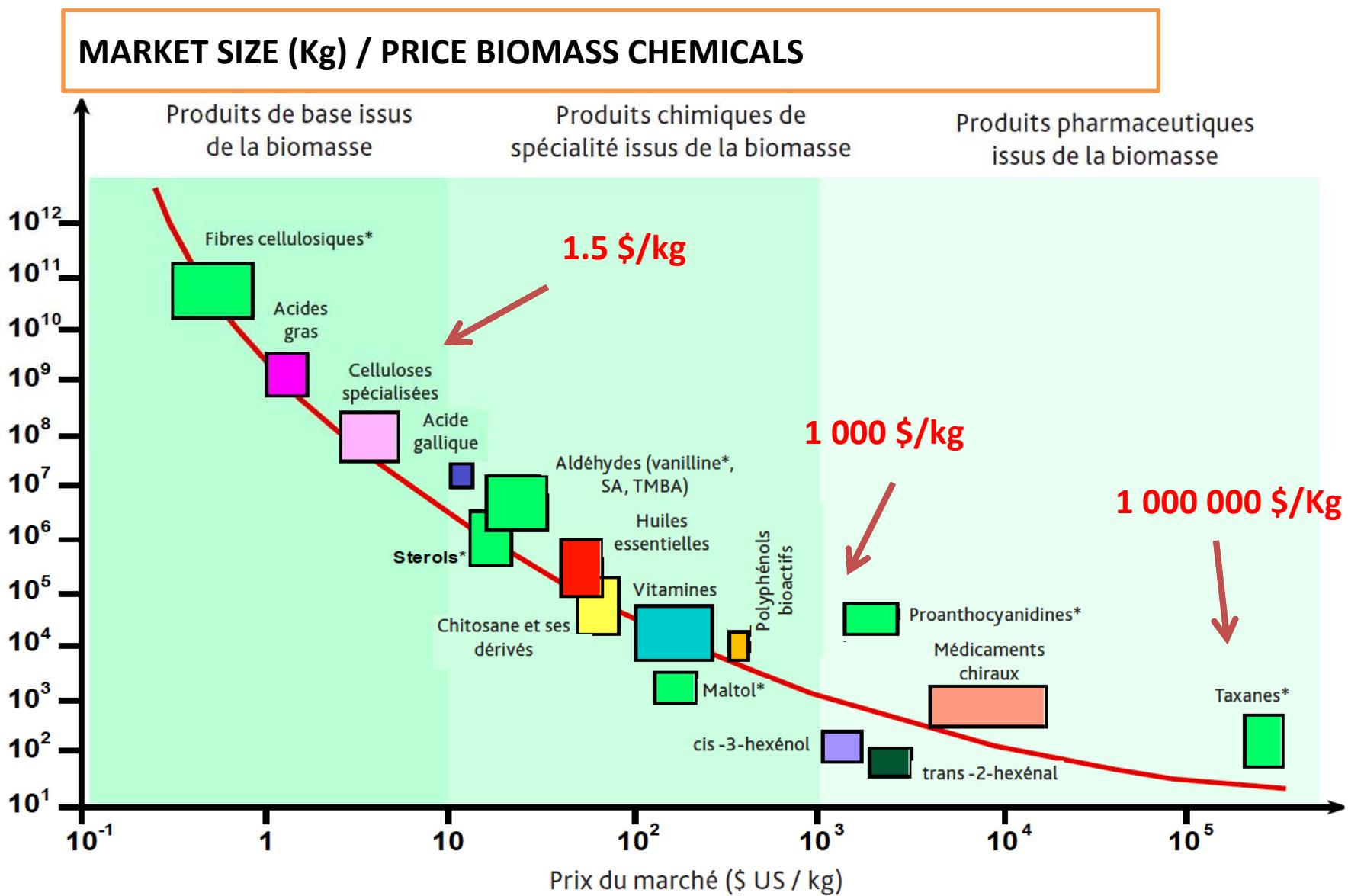


Typical wood chemical composition



Valorization wood byproducts

Our motto: « Extract the Best, Burn the Rest »



VALORISATION OF CELLULOSE TO PAPER PULP

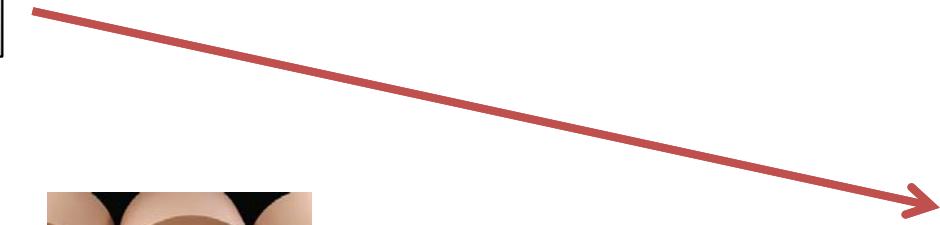


3 PAPER PULP PROCESSES

- KRAFT process
- BISULFITE process
- TMP process

PAPER PULP INDUSTRY IN FRANCE

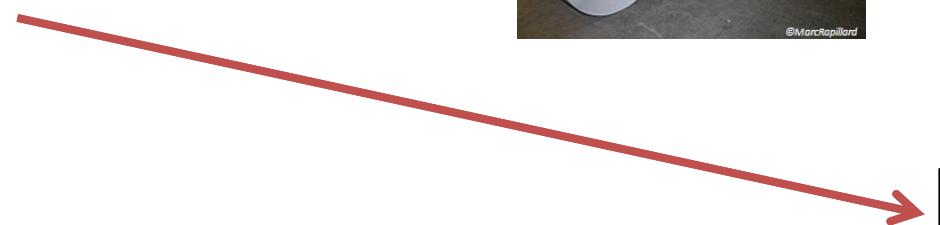
2 500 Ktons (2004)



1 724 Ktons (2009)



17 sites (2004)



12 sites (2009)



INDUSTRIAL CHANGE OF THE PAPER PULP INDUSTRY

AQUITAINE REGION

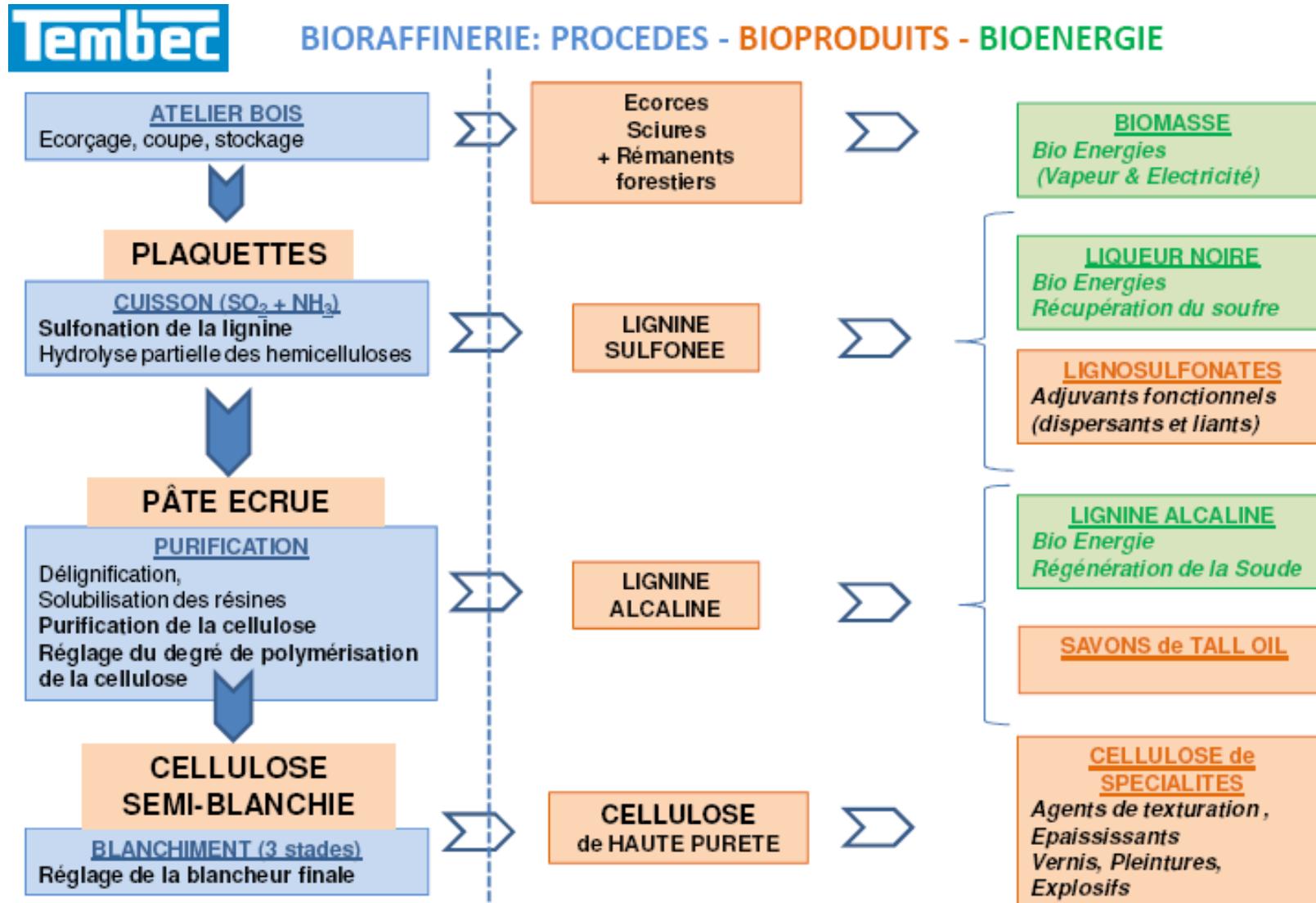
Large Scale Wood Biomass Bio-Refinery



Tembec

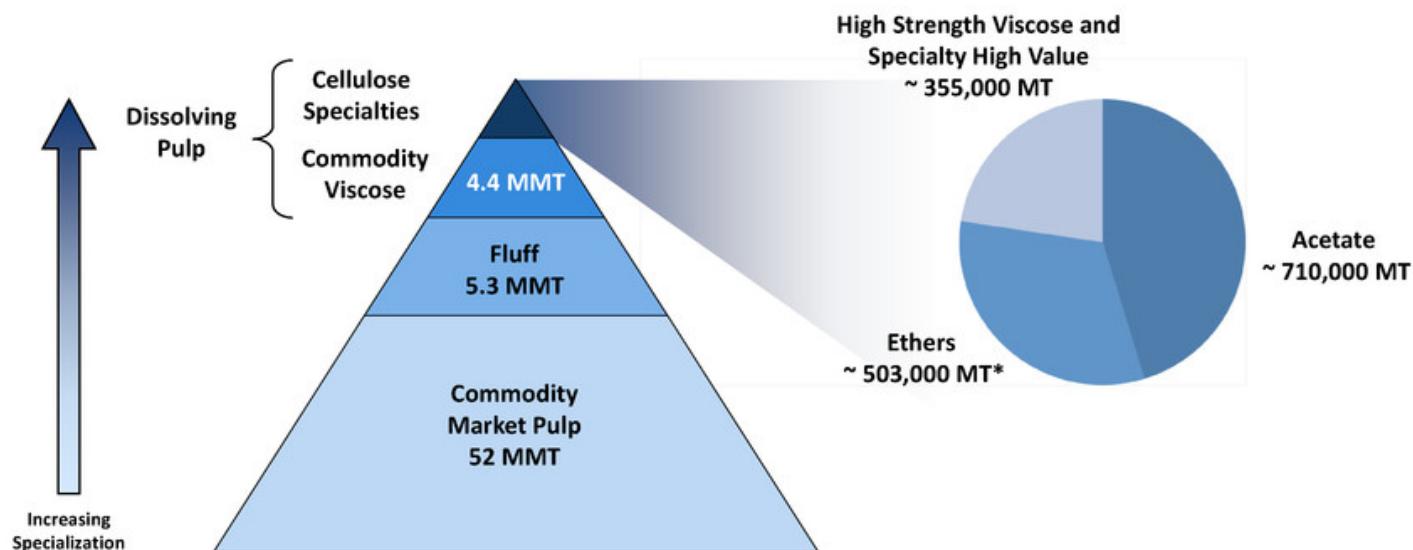


TEMbec: A SUCCESSFUL INDUSTRIAL CHANGE



VALORISATION TOWARDS CELLULOSE SPECIALTIES

Cellulose Specialties is a High-Value Product



* Includes some lower purity, less demanding grades

(1) Represents chemical (Kraft and Sulfite) pulp market

VALORISATION TOWARDS CELLULOSE SPECIALTIES

Acétate de cellulose



Optical films for LCD screens



Media Filters



High Quality Textiles

VALORISATION TOWARDS CELLULOSE SPECIALTIES

Ether cellulose



Coating for tablets



Texturing agent for food



Anti-splash agents for paints

VALORISATION TOWARDS CELLULOSE SPECIALTIES

Nitrocellulose



Nail polish



Lacquers



Inks

LIGNIN VALORISATION



ADDITIVES FOR CONCRETE APPLICATIONS

LIGNIN VALORISATION

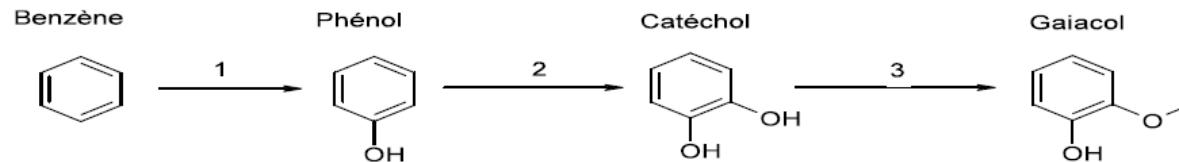


PRODUCTION OF VANILLIN

Source: Frost & Sullivan 2012

Industrial Synthesis of Vanillin via the Gaïacol route

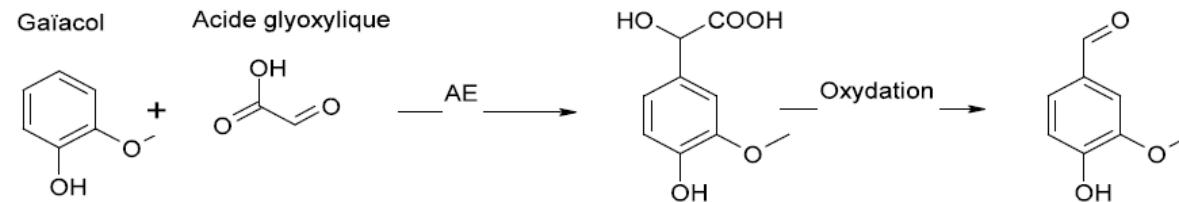
Synthèse du gaïacol



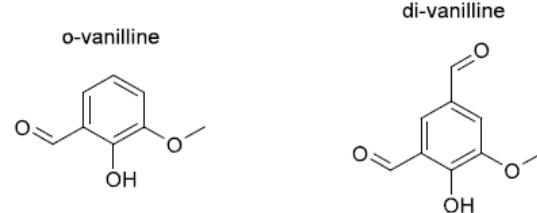
1 et 2 : substitution du cycle aromatique

3 : Synthèse de Williamson

Synthèse à partir du gaïacol (Rhodia)



Sous-produits de la synthèse de Reimer



Ainsi que restes de réactifs,
de solvants, de produits non
oxydés...

VANILLIN SYNTHESIS FROM LIGNIN



Sulfite wood pulp process



Black Liquor
45% lignin / 30% sugar/28% inorganic components



Ultrafiltration
Lignin enriched concentrate
74% lignin on dry matter basis



Oxidation alkaline conditions
100-170°C, O₂, catalyst copper sulphate

The Vanillin Global Market

(Market data 2011)



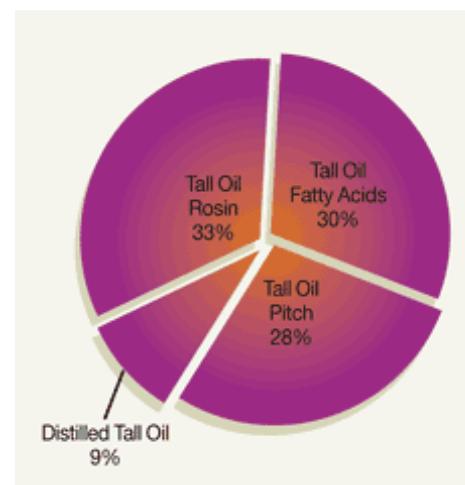
Vanillin type	Market volume (tons)	Market value USD	Average price USD /Kg
Lignin based	3200	38 400 000	12
Crude oil	12 800	153 600 000	12
natural vanilin	60	36 000 000	600
TOTAL	16 000	228 000 000	14

Source: Frost & Sullivan 2012

VALORISATION OF CRUDE TALL OIL



- By-product of the KRAFT paper pulp process
- 30 to 50 Kg per ton pulp → 1 800 Ktons/year (2013)
- Composition of Crude Tall Oil (CTO): rosins, fatty acids, sterols
- CTO distillation → Tall Oil Rosin (**TOR**), Tall Oil Fatty Acid (**TOFA**), Distilled Tall Oil (**DTO**)



Source: AFORCHEM 2013

VALORISATION OF TALL OIL DERIVATIVES



TOFA & TOR: ALKYD RESINS FOR INKS & PAINTS

(Polyesters derived from the reaction of TOFA with polyols and anhydrides)



TOFA: additives for oil drilling

(corrosion inhibitors)



TOFA: additives for fuels

(lubricant effect)



TOR: tackifier resins

(Raw materials for Hot Met Adhesives)

VALORISATION OF SULPHATE TURPENTINE



- Condensates collected during the KRAFT cooking process
- Composition: monoterpenes C10: alpha-pinene (60 - 65%), beta-pinene (25-35%)
- 40 Kg sulphate turpentine / Ton pulp
- Worldwide production: 235 000 tons → 100 000 tons for the aroma chemicals market

VALORISATION ESSENCE DE TEREBENTHINE AU SULFATE EN PRODUITS AROMATIQUES



- Worldwide consumption of terpenic aroma: 55 000 tons/year
- Market value: 600 Millions USD (2010)

Region	Consumption Million Dollars	Percentage
United States	242	38
Western Europe	213	34
Japan	70	11
China	60	10
Other	45	7
TOTAL	630	100

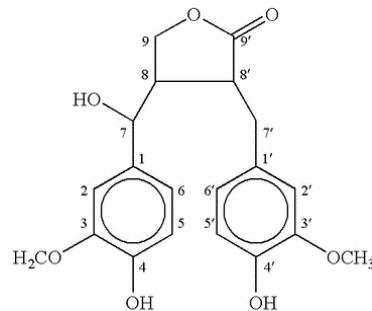
VALORISATION OF EXTRACTIVES LIGNANS



SPRUCE



KNOTS



HMR LIGNAN: HydroxyMataiResinol

Linnea
Extraction éthanol



VALORISATION OF EXTRACTIVES

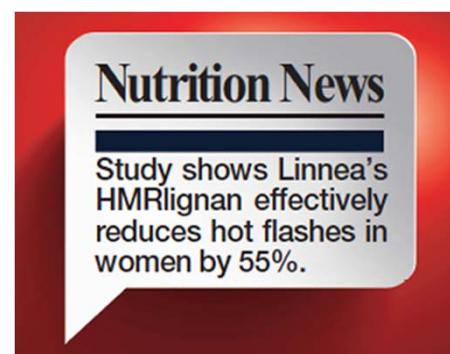
HMR Lignans



Menopause



Cardiovascular diseases



Prostate cancer Treatment

VALORISATION OF EXTRACTIVES

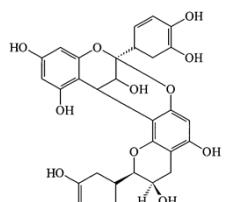
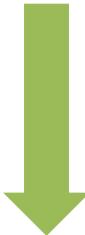
Oligomeric proanthocyanidins



Maritime pine



Barks

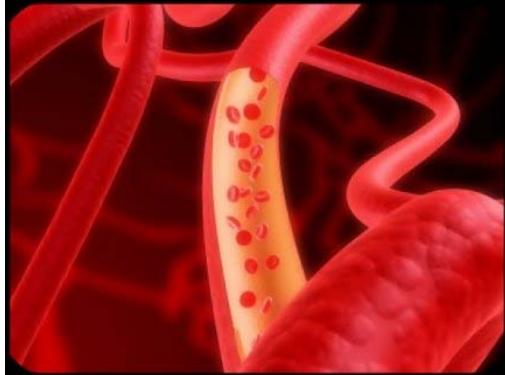


Oligomere Procyanoindine



VALORISATION DES EXTRACTIBLES

Oligomeric proanthocyanidins



Blood circulation



Retina protection



Relieve joint pains



Skin protection

VALORISATION OF EXTRACTIVES

Hydrolysable Tannins

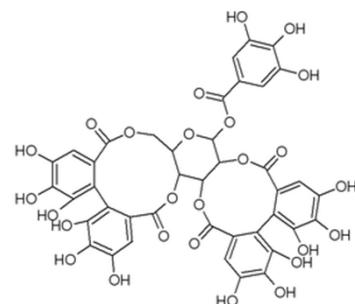


Oak



Chestnut

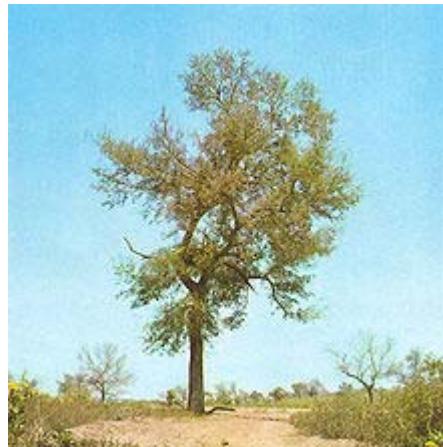
SILVATEAM



Ellagitanins

VALORISATION OF EXTRACTIVES

Condensed Tannins



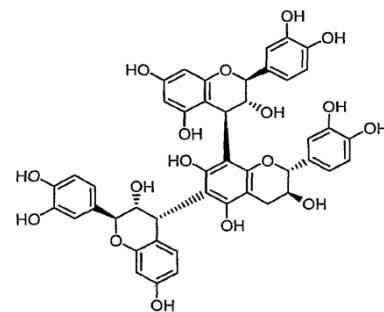
Quebracho



Mimosa



SILVATEAM



Profisetinidins

VALORISATION OF EXTRACTIVES

Industrial Applications of Tannins



Leather tanning industry



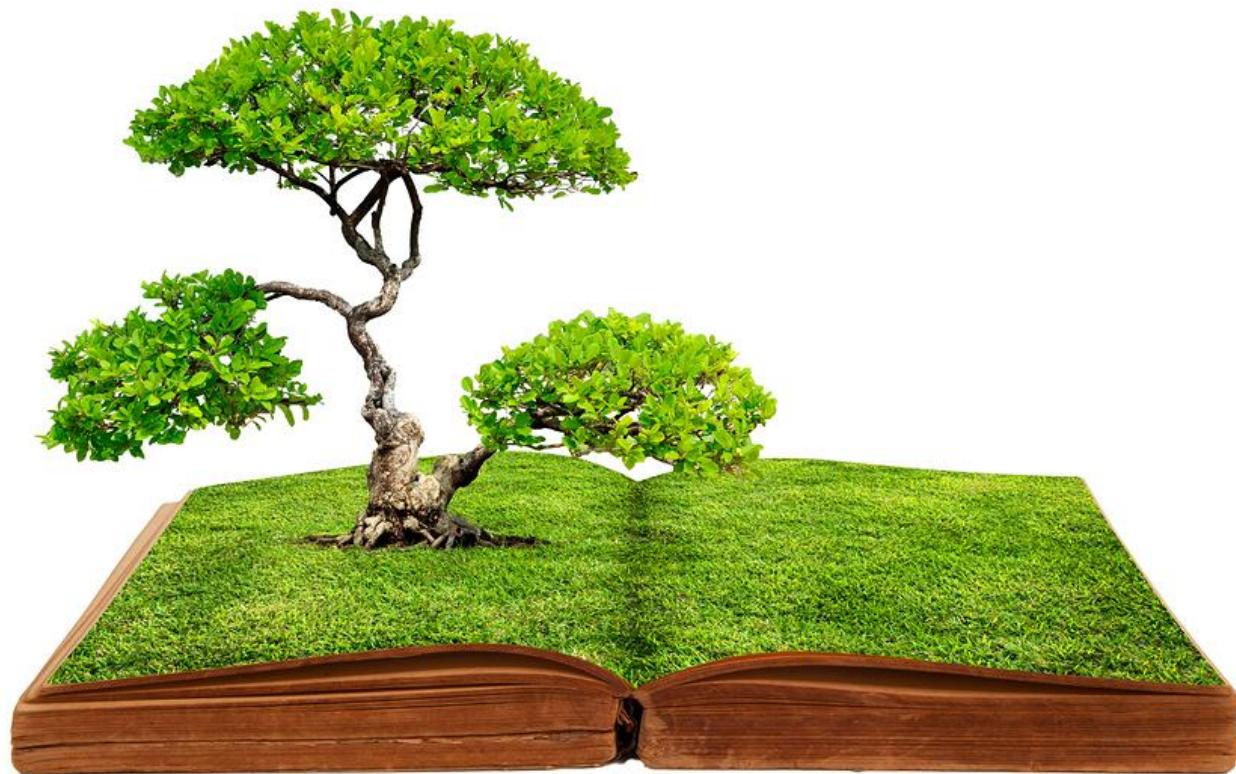
Die fixing agent



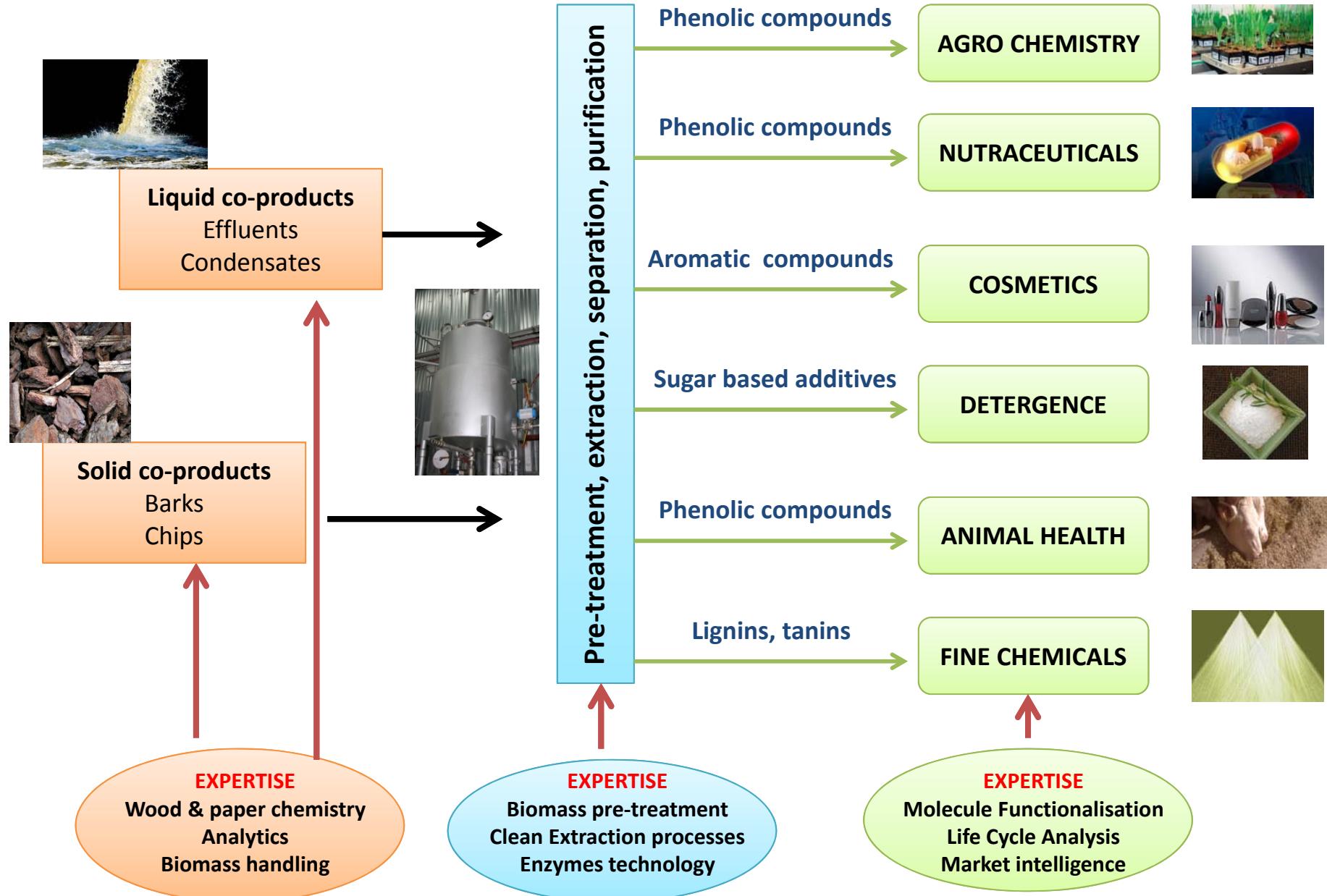
Animal feed

Wood Chemistry

New Fields of Applications



New Developments: 30 R&D projects elaborated



LIGNOCELLMARKET

Brand name for wood based chemistry

- **LIGNOCELLMARKET** covers all actions of the French competitiveness clusters XYLOFUTUR related to wood based chemistry.
- **LIGNOCELLMARKET** aims at accompanying the wood converters (forest/wood/paper) in the valorization of this specific biomass for the chemistry industry
- The development of the wood chemistry initiative **LIGNOCELLMARKET** is supported by the research organization PolyBridge®.

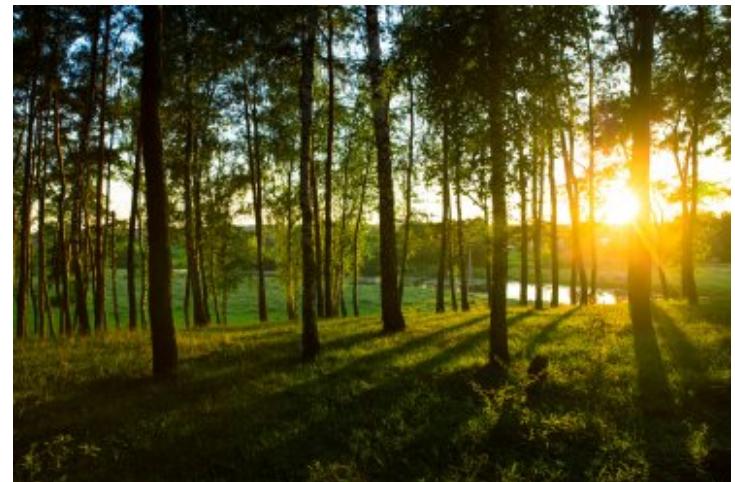
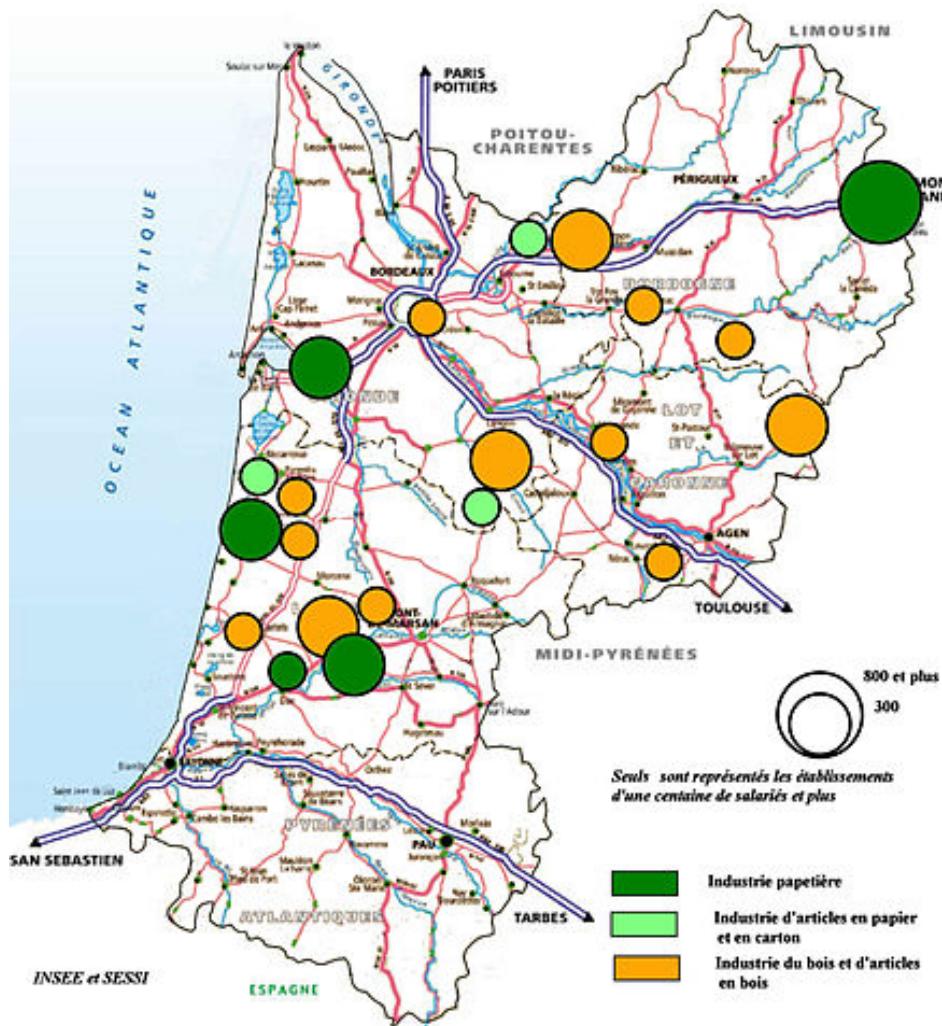


**LIGNOCCELLMARKET initiative
is driven by
the cluster XYLOFUTUR in AQUITAIN**



AQUITAINE is not only a Wine Region.....

LIGNOCELLMARKET initiative is driven by the cluster XYLOFUTUR in AQUITAINE



... but also a Dynamic Forestry & Wood Industry Region

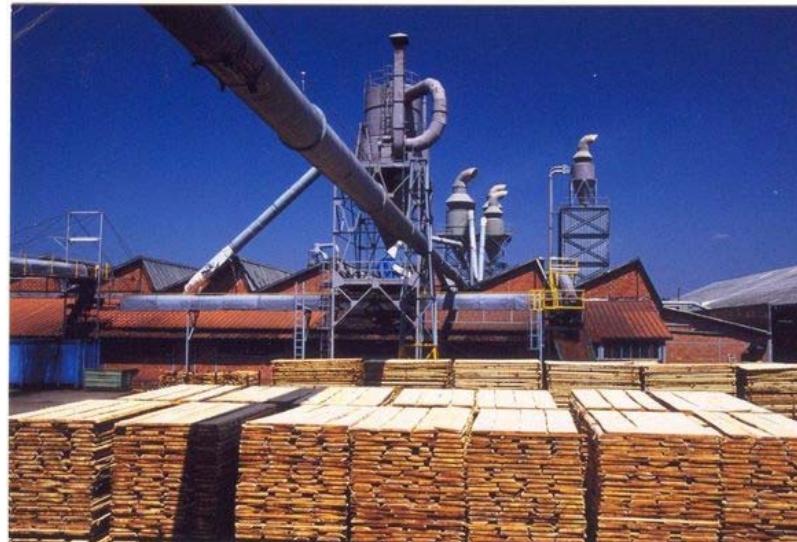
AQUITAINE REGION

Major Paper Pulp Manufacturers



AQUITAINE REGION

Major Wood Converters



AQUITAINE REGION

Large Scale Wood Biomass Bio-Refinery



Tembec



AQUITAINE REGION

Large Scale Industrial Expertise in Extraction Technologies



Match-Making Activity

Create a BRIDGE between « Chemists » & « Wood Industry »

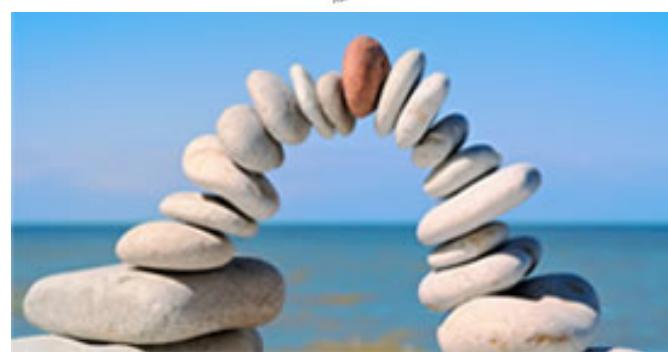


A strong network in the world of academic research



Build-up Bridges between the Wood & the Chemical Industry

- Organisation of cross-regional tours for up-stream and down-stream companies in Aquitaine and in Spain.
- Participation to workshops to identify new project trails
- Elaboration of mutual R&D projects
- Elaboration of mutual industrial Projects





Building Bridges between Forestry & Chemistry

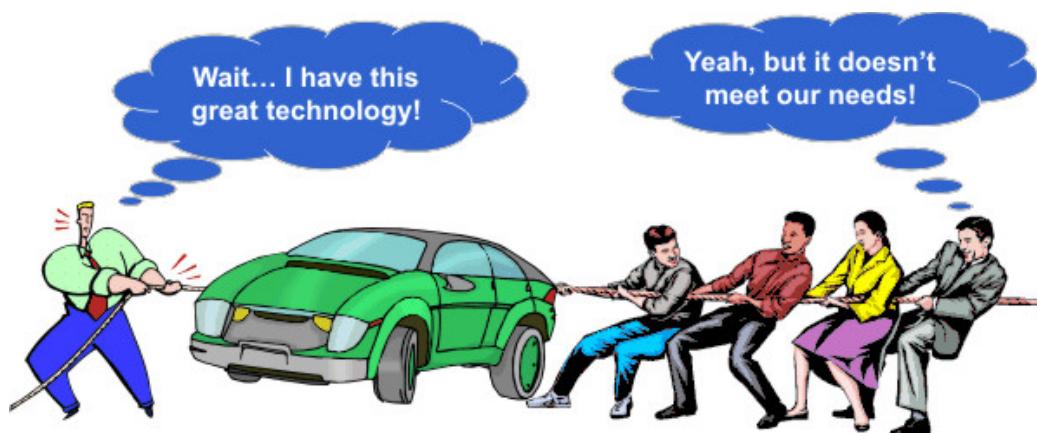
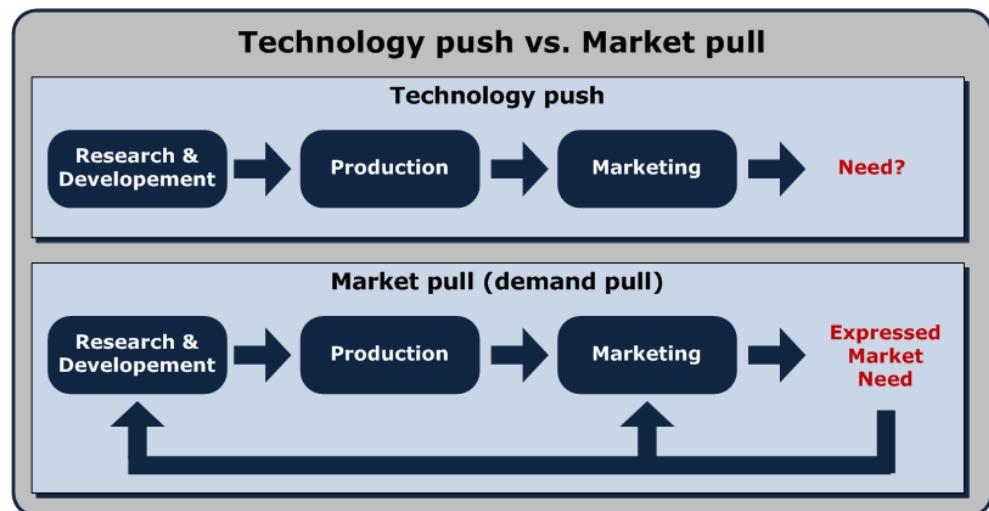
Support European Bio-Economy Programs

THE OLIGOLIGNOX PROJECT



OLIGOLIGNOX Project

A Market Pull Initiative



OLIGOLIGNOX Project

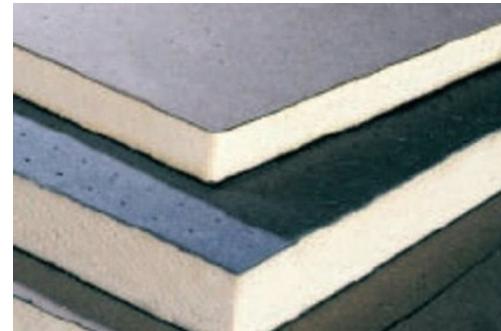
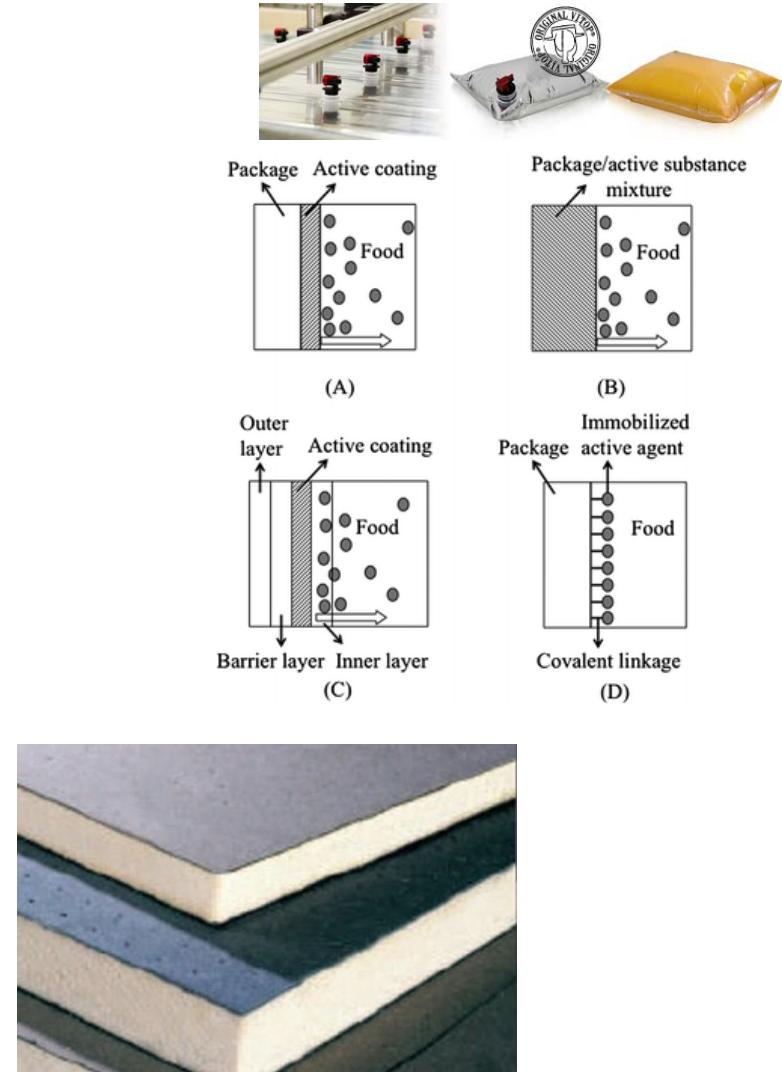
Voice of the Downstream Markets



Bio Bitumen

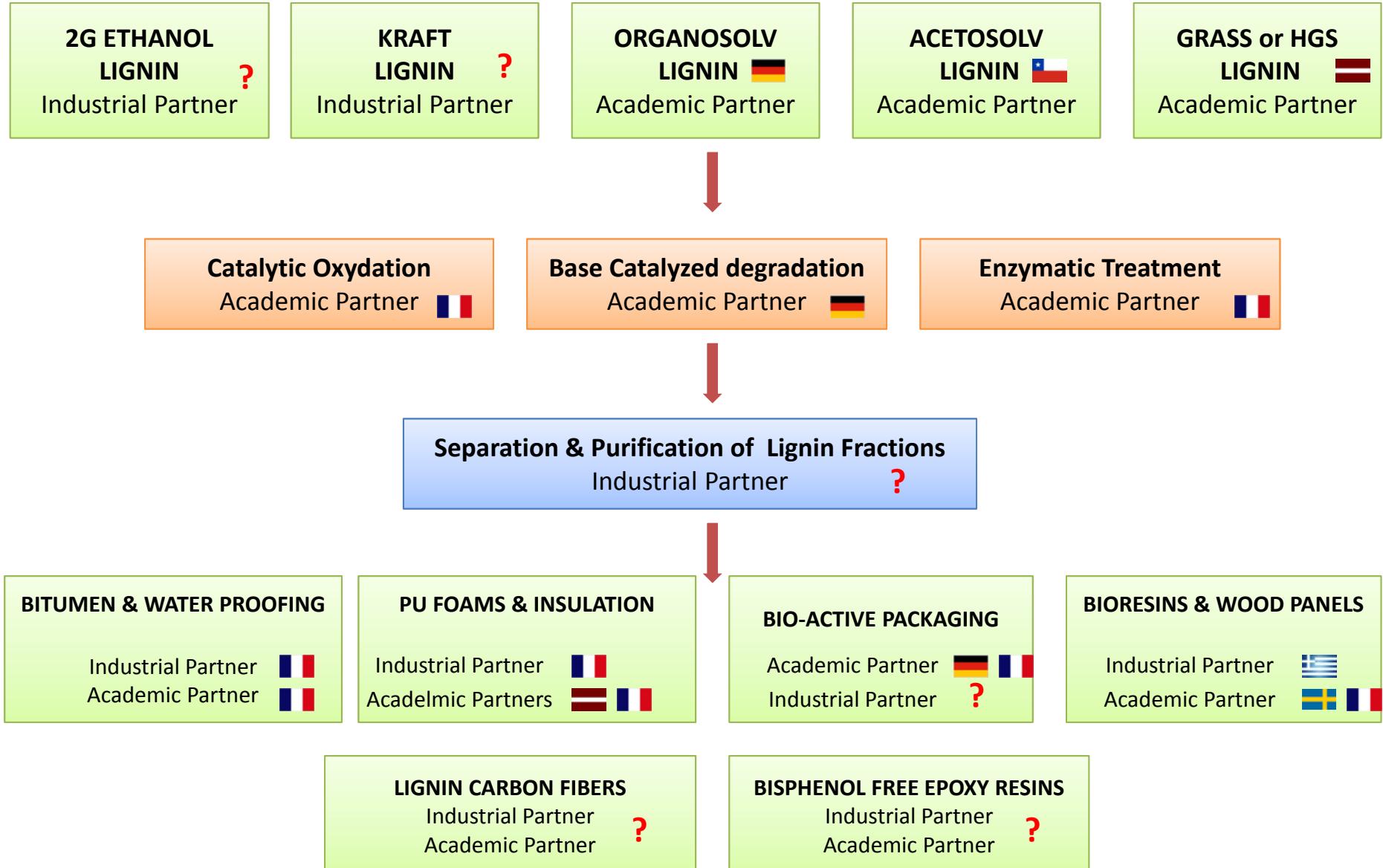


Bio-resins for Wood Panels



Insulation PU Foam

OLIGOLIGNOX Project

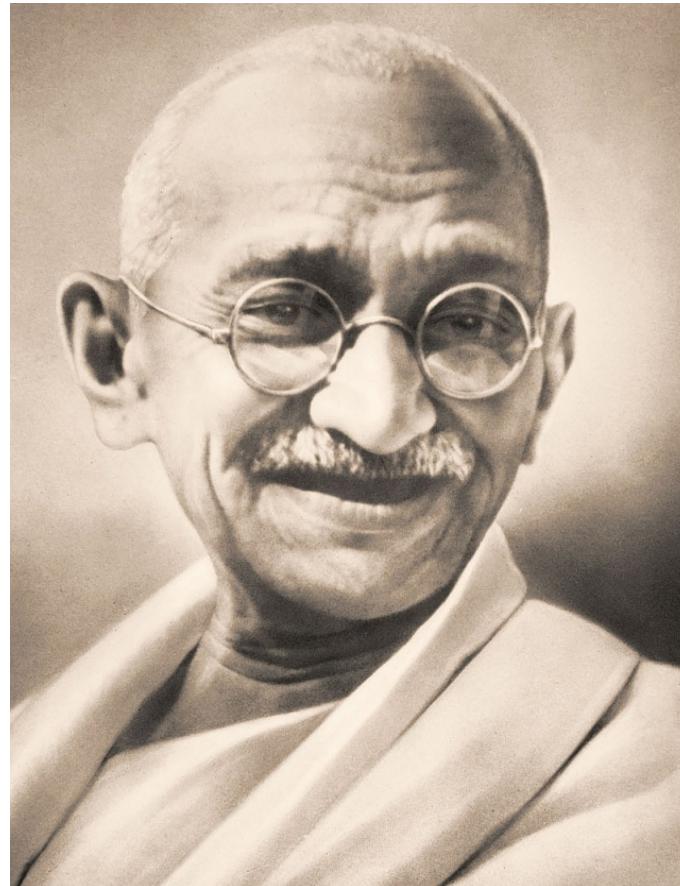


Industrial partners we are looking for.....

- Identify a **PAPER PULP producer** interested in valorizing **KRAFT LIGNIN**.
- Integrate their eventual **PACKAGING UNIT** to validate the bio-active packaging materials.
- Identify a **2G CELLULOSIC ETHANOL producer** interested in valorizing its **LIGNIN BY-PRODUCT**.
- Identify a **FIBER CARBONE producer** for the development **of LIGNIN derived CARBON FIBERS** for **STORAGE ENERGY** applications.
- Identify an **EPOXY RESIN producer** for the development **of BISPHENOL A free formulations**.
- Identify an **EQUIPMENT producer** having an expertise in **PURIFICATION** and **SEPARATION** technologies.



“ We must become the change we want to see”.



Gandhi

