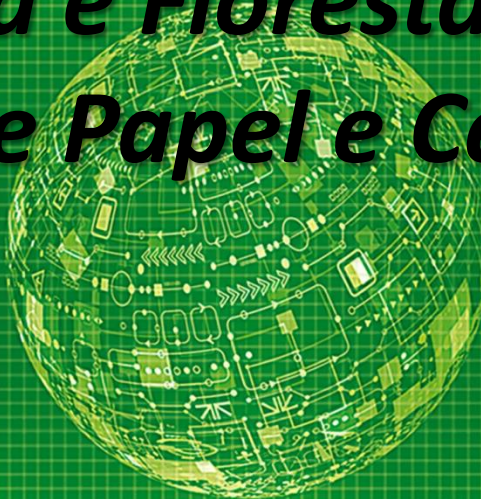




ABTCP | 50^o Congresso Internacional de
2017 | Celulose e Papel
50th Pulp and Paper International Congress

23 a 25 de outubro
October 23th to 25th
Hotel Unique
São Paulo
Brasil / Brazil

Bioeconomia e Florestas: Potencial além de Papel e Celulose



Paulo Luiz de Andrade Coutinho
Instituto Senai de Inovação em Biossintéticos



Realização:



Correalização:



AGENDA

- TENDÊNCIAS E “DRIVERS” TECNOLÓGICOS: IMPACTO NA INDÚSTRIA
- A BIOREFINARIA DE PAPEL E CELULOSE: ESFORÇOS EM ANDAMENTO
- A BIOREFINARIA DE PAPEL E CELULOSE: OPORTUNIDADES A EXPLORAR
- CONCLUSÕES

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Megatendências e Tecnologias em evidência



**Crescimento /
Envelhecimento
População**



**Mudanças
Climáticas**



**Aceleração
das
Mudanças
Tecnológicas**



**Energia
Novo Mix
Maior Eficiência
Armazenamento**



**Globalização
Urbanização
Mobilidade**



Saúde

IT and how we use it

Machines working for us

Rethinking energy comes of age

Changing the building blocks of everything



Mobile Internet



Cloud technology



Internet of Things



Automation of knowledge work



Advanced robotics



Autonomous and near-autonomous vehicles



3D printing



Energy storage



Advanced oil and gas exploration and recovery



Renewable energy



Next-generation genomics



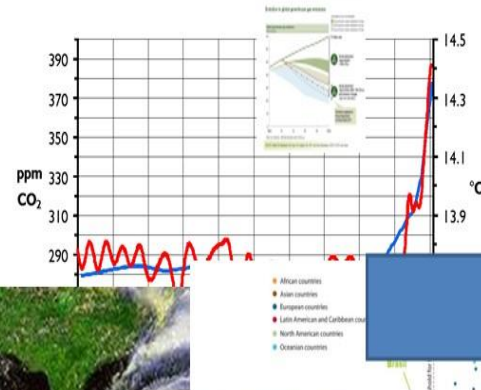
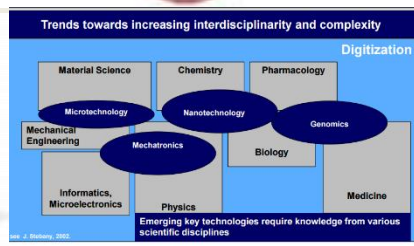
Advanced materials

Convergência Tecnológica...

E Sustentabilidade...



DESENVOLVIMENTO DE HABILIDADES DE COOPERAÇÃO COMO DESAFIO INOVAÇÃO ABERTA

ACV vs ECONOMIA CIRCULAR

on sales
AkzoNobel
Resource efficiency
Improve resource efficiency across the full value chain
Carbon emissions
Reduce our carbon emissions across the value chain by 20 percent (our ton) by 2020 (2012 base)



Biotecnologia e Nanotecnologia...

Feedstock

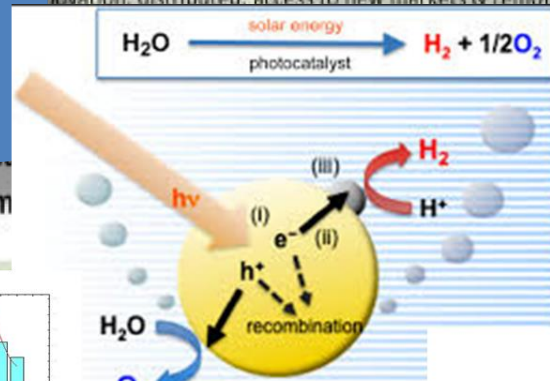
Biochemical Processing

Chemical Products

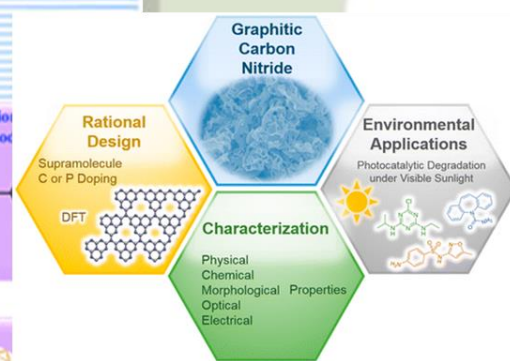
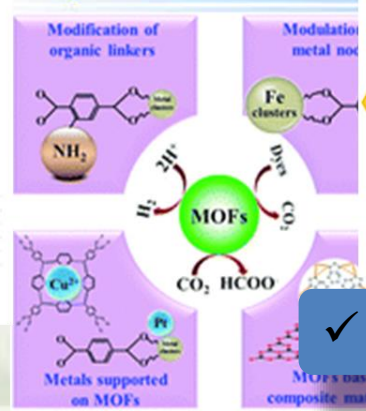
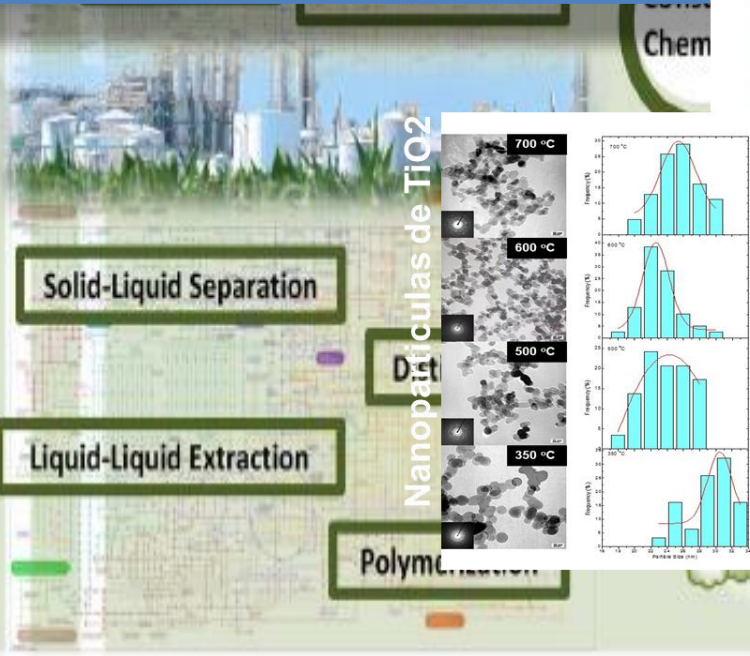
- ✓ NOVA ENGENHARIA
- ✓ NOVAS MOLÉCULAS / NOVOS POLÍMEROS
- ✓ DESENVOLVIMENTO DE APLICAÇÃO
- ✓ METANO / CO2?

Advantages of industrial biomanufacturing

products at high selectivity, carbon & energy efficient, mild conditions, operational complexity, small scale, capital efficient, lower financial risk, innovation, distributed, access to new markets & remote resources



- Biomass
- Natural Gas & Biogas
- Industrial Byproducts



✓ FOTOCATÁLISE?

Intensificação de Processos...

Singularidade ...

In Fine Chemicals and Advanced Materials:
'smaller is beautiful' because
continuous mode performs better

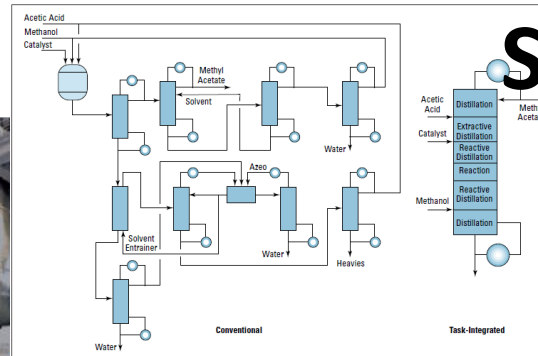


Figure 9. Task-integrated methyl acetate column is much simpler than conventional plant. (Drawing courtesy of Eastman Chemical (76).



Batch 5m³
-20°C, 5h, yield 72%



ref: Merck

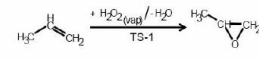
5 MINI-reactors
0°C < 1 mn
continuous
yield >92%



Projekt
reacto

- ✓ REDUZ CAPEX
- ✓ AUMENTA EFICIÊNCIA
- ✓ REDUZ IMPORTÂNCIA DO FATOR DE ESCALA
- ✓ AUMENTA A SEGURANÇA

Model synthesis:



Features:

- Modular (u
- Multi-purpo
- Reaction u
- Reactions s

SINGULARIDADE 2030 – 2040 COMPUTADORES SUPER INTELIGENTES

- Evoluem;
- Não dependem da interferência humana;
- Utilizam fontes renováveis de energia.

Delocalized productions
inventories... bu

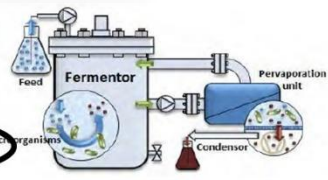
- Interox: 1 ton/day peroxy!
- Kvaerner: phosgene COCl₂
- hydrogen cyanide, chlc

Traditionally batchwise

- Low product concentrations due to product toxicity
- Low productivity, while high cost of substrates
- High purification costs

Integration with OPV

- Continuous, selective product withdrawal from reaction medium from 20 g.L⁻¹ to >200 g.L⁻¹
- Low energy demanding separation technique



Continuous process

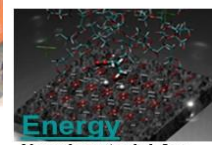
- Productivity enhancement by removal of product inhibition from 0.36 g.L⁻¹.h⁻¹ to 1.13 g.L⁻¹.h⁻¹
- Concentrated feedstocks can be fermented
- Energy gains from complementation of distillation with efficient primary work-up step



15/07/2014
© 2011, VITO NV

45

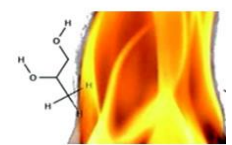
IBM Research - Zurich Laboratory.



Energy
Novel material for
"green energy"
application



Material discovery
Application of
computational
resources.



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Os esforços da Tembec..



Rooted in tomorrow.

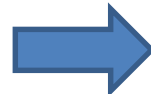
QUÍMICOS

Products	Applications	
Resins	Phenolic resin powder	OSB (oriented strand board)
	Phenolic resin liquid	LVL (laminated veneer lumber)
		MDF (medium density fiberboard)
		OSB (oriented strand board)
		Plywood
		Particleboard and hardboard insulation
		Abrasives
	Amino resins – liquid and powder (MUF, UF, MF)	Door skin veneer
		Plywood
		Truck Floors
PMUF	OSB (oriented strand board)	
Emulsion Waxes	OSB (oriented strand board)	
Formaldehyde	37%-52% concentrations	
Lignosulfonates	Agriculture	
	Animal feed	
	Carbon black	
	Concrete admixtures	
	Dust suppressants	

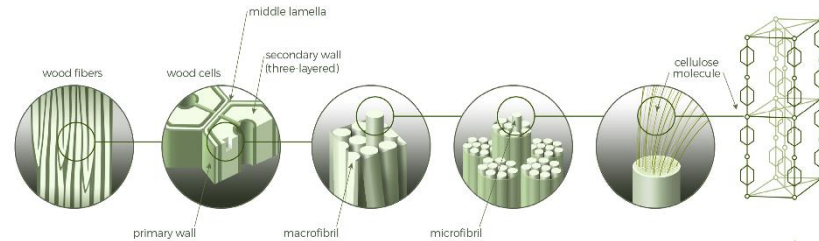
ESPECIALIDADES DA CELULOSE

Products	Business lines	Market segments	Applications
Tembec manufactures specialty cellulose, in rolls and bales, at two facilities: <ul style="list-style-type: none"> • Temiscaming, Canada • Tartas, France 	Producers of cellulose ethers	Pharmaceuticals	Film coating for pills
		Food	Texturizer and stabilizer
		Personal care	Thickening agent
		Construction	Splatter control agents in paints, adhesives, mortar and plaster
		Oil drilling	Thinning agents in drilling mud
	Producers of cellulose acetate	Textiles	Fibers and threads for quality fabrics
		Electronics	Optical film for LCD technology
		Consumer products	Fibers for filtration media
	Producers of nitrocellulose	Cosmetics	Nail polish
		Paint	Quick drying lacquers and varnishes
Specialty		Inks and coatings	
Producers of microcrystalline cellulose (MCC)	Mining	Explosives	
	Pharmaceuticals	Binder	
	Food	Hydrocolloids	

Os esforços da Domtar...



Extracting CNC from trees



Oil and gas



Metso-supplied world's first commercial **LignoBoost** plant successfully starts up at Domtar in the USA



BioChoice™ Lignin

Adhesives



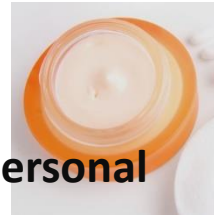
Paper and non-wovens



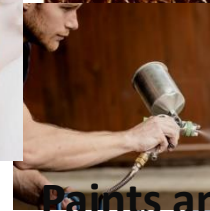
Cellulose nanocrystals are separated from the amorphous cellulose and are spindle shaped.



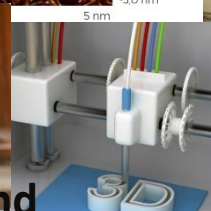
Personal Care



Paints and Coatings



Plastics and composites



Cement



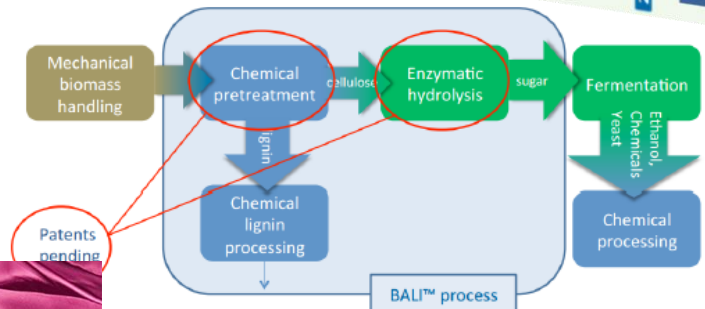
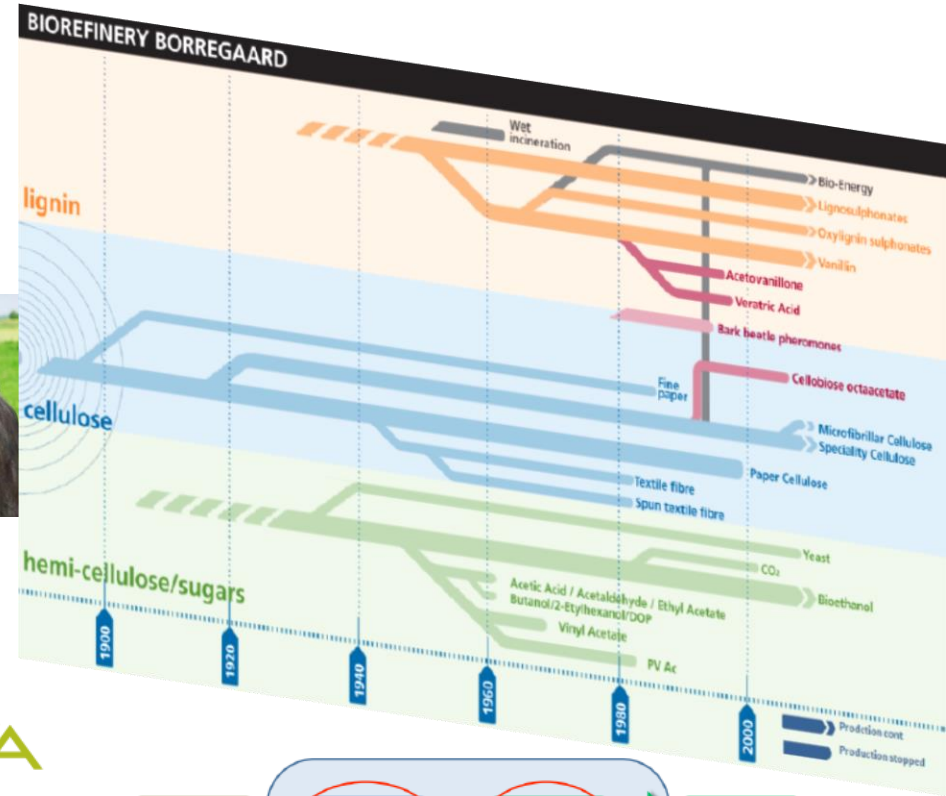
Os esforços da Borregaard...



Borregaard



Borregaard
LignoTech



Etapas do processo realizado na planta piloto BALI, e os 2 pedidos de patente pendentes. Fonte: BORREGAARD, 2013.

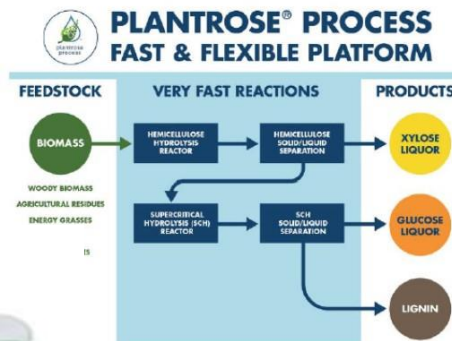
Os esforços da UPM...

UPM leads the integration of bio and forest industries into a new, sustainable and innovation-driven future. Our company consists of six business areas: *UPM Biorefining, UPM Energy, UPM Raflatac, UPM Specialty Papers, UPM Paper ENA (Europe & North America) and UPM Plywood*

The Biofore Company UPM



UPM



Plantrose® Process. Fonte: RENMATIX, 2016.

4 INNOVATION

New sources for sustainable growth and competitiveness
UPM is developing new businesses based on its extensive know-how and strong position in the forest biomass sourcing and processing value chain. Ecodesign represents business opportunities with large target markets and high added value.

BIOFUELS

- Advanced renewable diesel suitable for all diesel engines and renewable naphtha that can be used as a gasoline component

BIOCOMPOSITES

- Renewable materials to replace oil-based materials e.g. in injection moulding

BIOCHEMICALS

- Sustainable and competitive wood-based biochemicals with the focus on chemical building blocks, lignin products, biofibrils and biomedical products

Product, service and business model development in the current businesses is also an important source of competitive advantage and growth. All UPM businesses aim to increase the value added for customers through product and service development.



CRUDE TAIL OIL
A mixture of chemical groups, process containing several extractable components of wood.

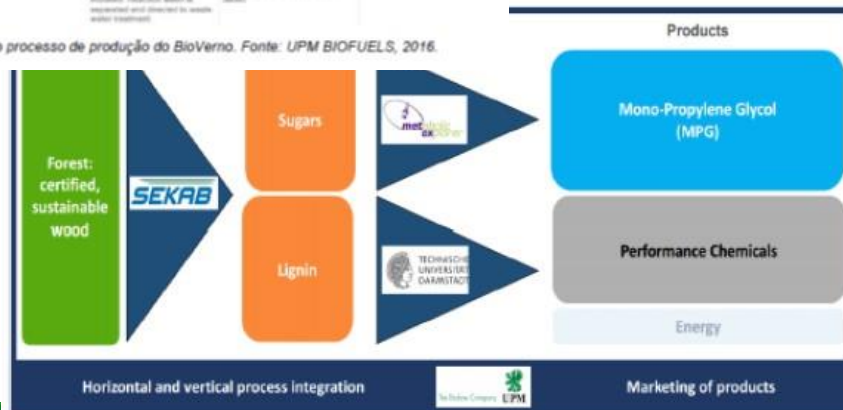
PRE-TREATMENT
Crude Tail Oil is purified with respect to solid particles and water are removed.

HYDRO-TREATMENT
Pre-treated Crude Tail Oil is fed together with hydrogen and nickel catalyst in the reactor where the chemical groups are modified. Reaction water is separated and directed to waste water treatment.

REACTION
Remaining hydrogen and nickel catalyst groups are removed. The remaining liquid is directed to separate compounds, distill.

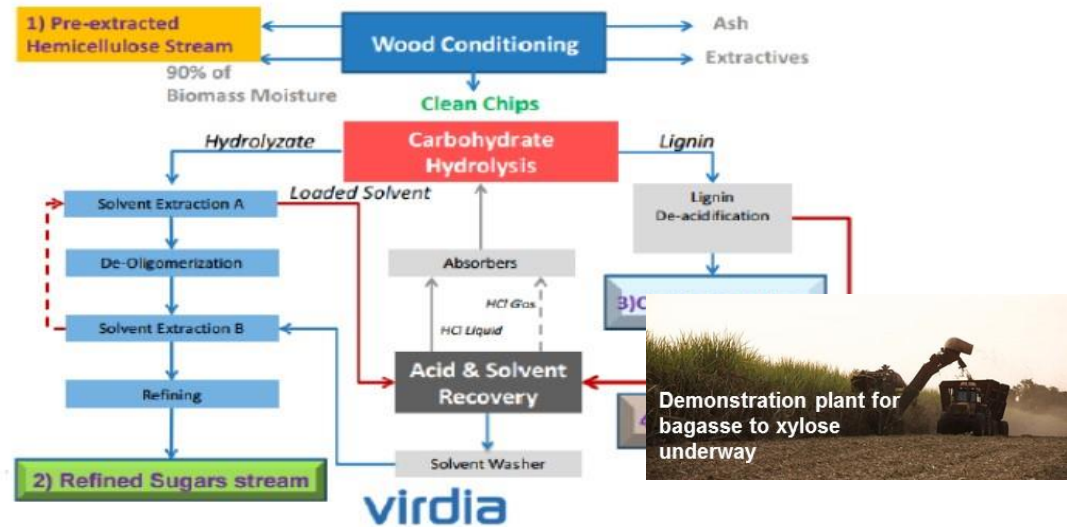
BIO-DIESEL
High quality, advanced biofuel suitable for all diesel engines.

Etapas do processo de produção do BioVerno. Fonte: UPM BIOFUELS, 2016.



Processo integrado do projeto ValChem. Fonte: VALCHEM, 2015.

Os esforços da Stora Enso...



:Processo CASE™ da Viridia. Fonte: VIRDIA, 2012.



Experts say that lignin may eventually be one of the new renewable materials extracted out of the green gold of the Nordic forests. Stora Enso's Sunila Pulp Mill in Finland will, in the future, extract lignin from pine and spruce.

Stora Enso strengthens bio-based chemicals development and signs a joint technology development and license agreement with Rennovia

<http://www.storaenso.com/news-and-media/pages/pressreleases.aspx?newsid=6CD59A8A73076BCA>



Replacing chemical fertilisers with fibre-based sludge

<http://renewablefuture.storaenso.com/our-story/replacing-chemical-fertilisers-with-fibre-based-sludge/>



Os esforços da Fibria...

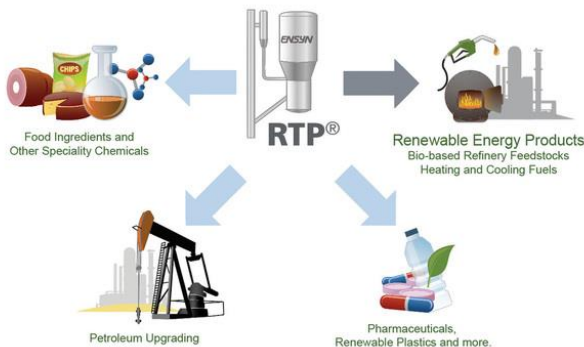


FIBRIA & ENSYN

Fibria and Ensyn operating a joint venture to produce RFO in Brazil... Ensyn and Fibria Celulose S.A., have established an equally-owned joint venture for the production of cellulosic fuels in Brazil using Ensyn's RTP® technology.

<http://www.ensyn.com/fibria-celulose-sa-and-ensyn.html>

RTP® - A Platform Technology



CelluForce and Fibria Cellulose Sign a Strategic Partnership Agreement, November 21, 2016

- Fibria invests CAD\$5.3 million in CelluForce and becomes a strategic shareholder
- The partnership provides Fibria with the exclusive right to sell and manufacture CelluForce NCC™ in the South American market
- CelluForce and Fibria will jointly develop additional cellulose nanocrystal applications , a variety of industrial and manufacturing uses



Fibria and Spinnova partnership!

Spinnova and Fibria started long term partnership

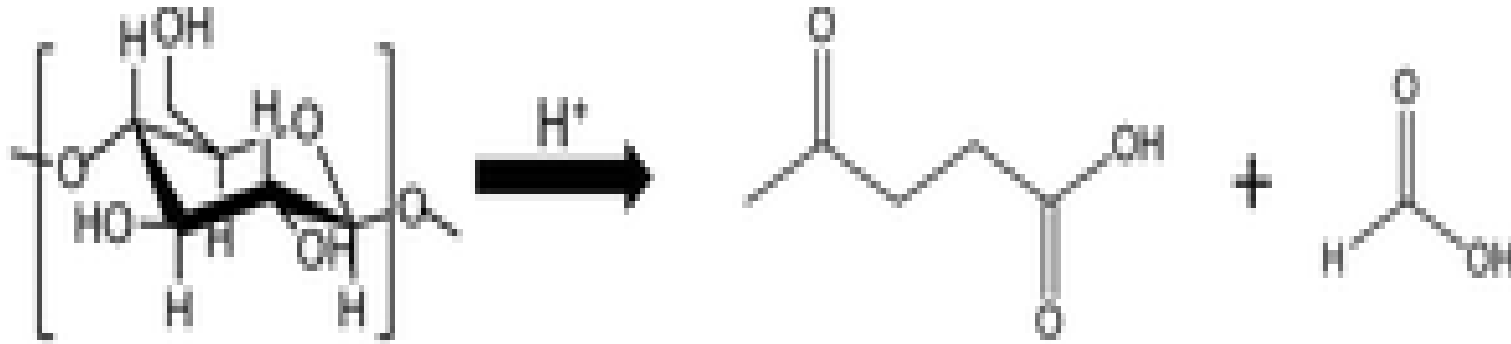
Spinnova has started long term partnership with Fibria, Brazilian forestry company and the world's leading producer of eucalyptus pulp from planted forests. Through 5 M€ investment Fibria is Spinnova's new minor shareholder and board member. To verify Spinnova technologies in pre-commercial scale it is agreed to start a joint development project targeting pilot scale production. It is also agreed to establish JV for the production and trading of Spinnova products when reaching commercial stage.



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Produtos a partir da (Ligno)Celulose / Glicose...

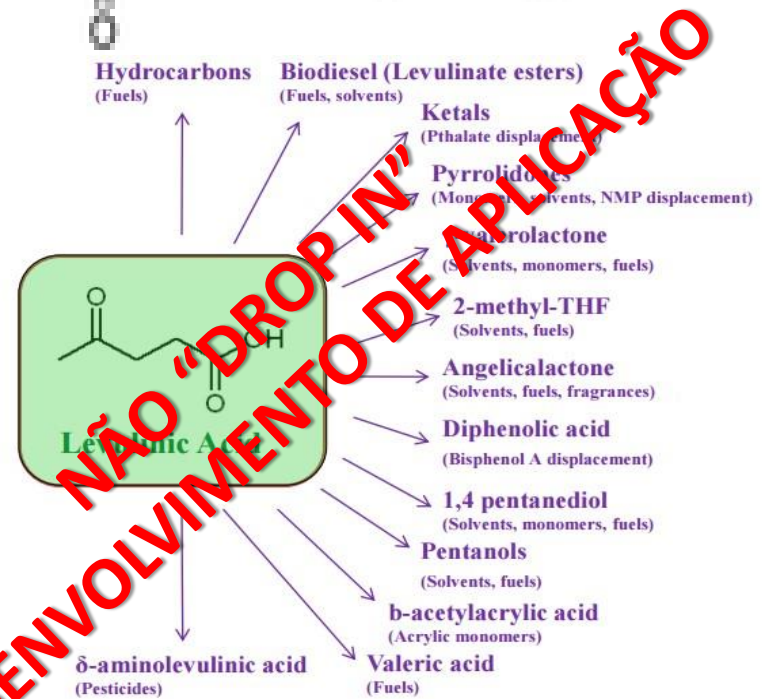


2015
CURRENT MARKET

2016
SPECIALTY MARKET

2020
LARGE VOLUME MARKET LAR

Personal Care F&F Pharma Dietary supplements Resins & Coatings	Personal Care Home Care & Laundry Heavy industrial cleaning MRO manufacturing Polymer and Adhesive removers BIO Polymers Inks Food contact Toys & Child Care	Adhesives and Coatings	Agricultural products PVC sheets Flexible PVC Flooring Plastisols	
--	--	------------------------	---	--



Produtos a partir da Celulose / Glicose...

Novos Têxteis / O

Consumo do Brasil de fibra de viscosa

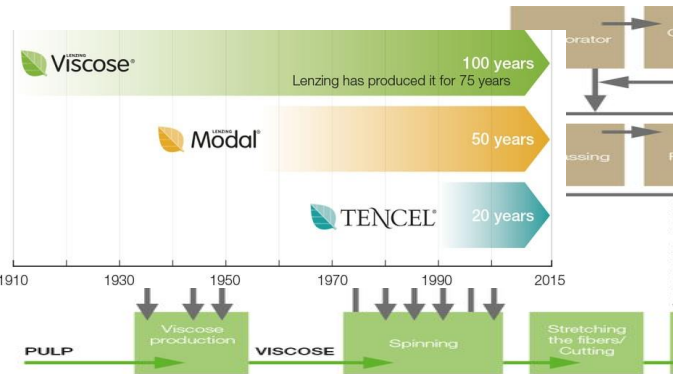
	2010	2011	2012	2013*
Produção	20.723	18.109	19.466	7.683
Exportação	6.967	1.008	425	428
Importação	10.079	7.472	7.202	8.999

Fontes: Produção (ABRAFAS) / Exportação e Importação (Aliceweb) / Consumo (ABRAFAS)

*Período em que a produção de viscose no Brasil foi encerrada, por importação como tecido.

Preço médio de venda do filamento de viscose no mundo

(USD/Ton)	2012	2013	2014
Preço	2.232	1.959	1.850



	KEY ENABLER: Adaptation of pulp is done to get desired properties of the cellulose pulp for the following processes.	TRL ² 1-9 swerea
	Nonwovens can and are being produced directly in a modified paper machine using a wet laid nonwoven process. The challenge is to improve product performance.	TRL 5 swerea
	Spinning of nanofibrillated cellulose is a new technique for man-made continuous fibres of cellulose that do not need to take the circuitous road via first dissolving the cellulose.	TRL 5 swerea
	KEY ENABLER: Dissolving of cellulose from different types of waste to separate the pulp.	TRL 1-9 swerea
	Solution blowing is used directly from dissolved cellulose for high volume production.	
	Solution spinning is used for dissolved cellulose to produce fibers.	
	Textile processes like yarn spinning, twisting, carding, weaving, knitting, finishing, and plasma treatment to make a textile designed for a certain application or product.	TRL 7-9 swerea

Environmental

Fiber Composite for Automobile Armrest

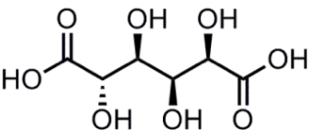
is the first time glass fiber-reinforced by a natural fiber-reinforced PP with out improved environmental impact. It is 20% lighter than conventionally harvested forestry by-products, neutral but 6% lighter, reduces tool costs energy 10% thanks to lower process cycles. From a lifecycle perspective it reduces CO₂ emissions by 11% and extends the vehicle's life.

NÃO "DROP IN" DESENVOLVIMENTO DE APLICAÇÃO

Fibres from textile waste to be turned into new attractive consumer products

Produtos a partir da Celulose / Glicose...

Químicos de Alto Rendimento...

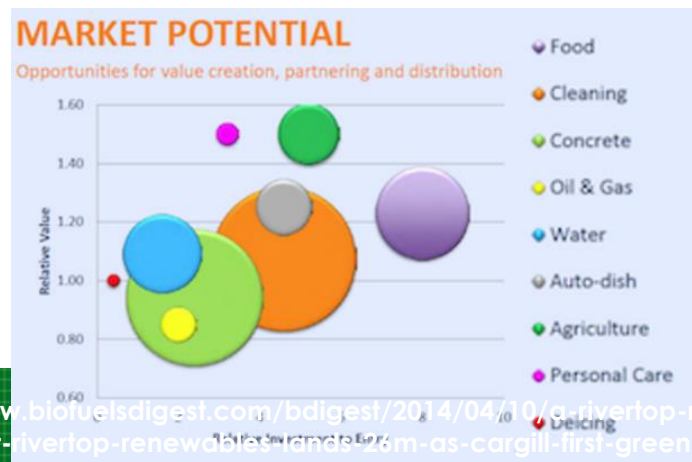
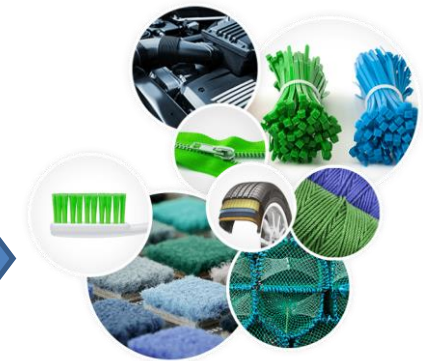


Ácido Glucárico



Ácido Adípico
Hexanodiol

NÃO "DROP IN"



CHELATION
The salts of RiverTop's sugar acids can be applied to chelate various metal ions. For example, RiverTop's Rise® detergent builder demonstrates binding capacity to sequester free calcium at a rate comparable to that of phosphates. [LEARN MORE](#)

pH MODIFICATION
Initial screening of RiverTop sugar acids has demonstrated a capacity to drop pH to levels suitable for various applications — from food to oil & gas applications. [LEARN MORE](#)

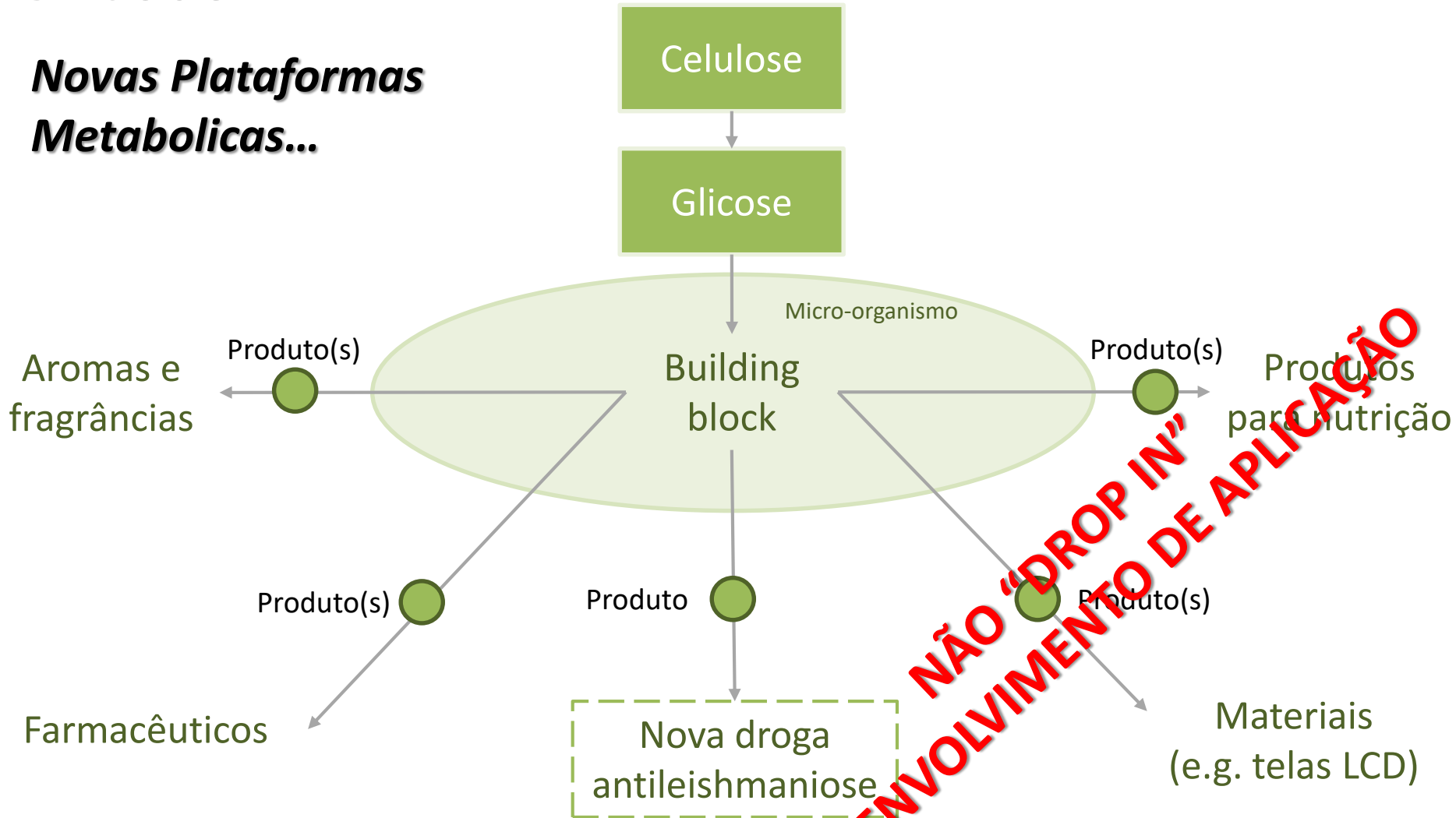
DISPERSION
Sustainable alternatives to polyacrylates are sought for application in products used in home and personal care, paints and concrete. [LEARN MORE](#)

ABSORPTION
A class of polymers, built from RiverTop sugar acids, have characteristics of high liquid absorbercy (indiscriminate of materials dissolved or suspended in the liquid), moisture stability, and activation by heat and/or pressure. [LEARN MORE](#)

NÃO "DROP IN"
DESENVOLVIMENTO DE APLICAÇÃO

Produtos a partir da Celulose / Glicose...

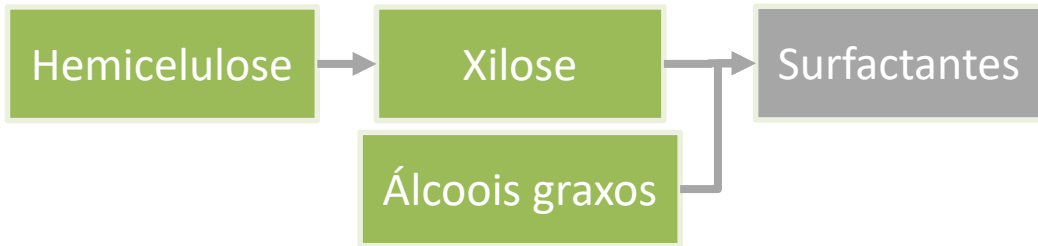
*Novas Plataformas
Metabolicas...*



NÃO "DROP IN" DESENVOLVIMENTO DE APLICAÇÃO

Produtos a Partir da Hemicelulose / Xilose...

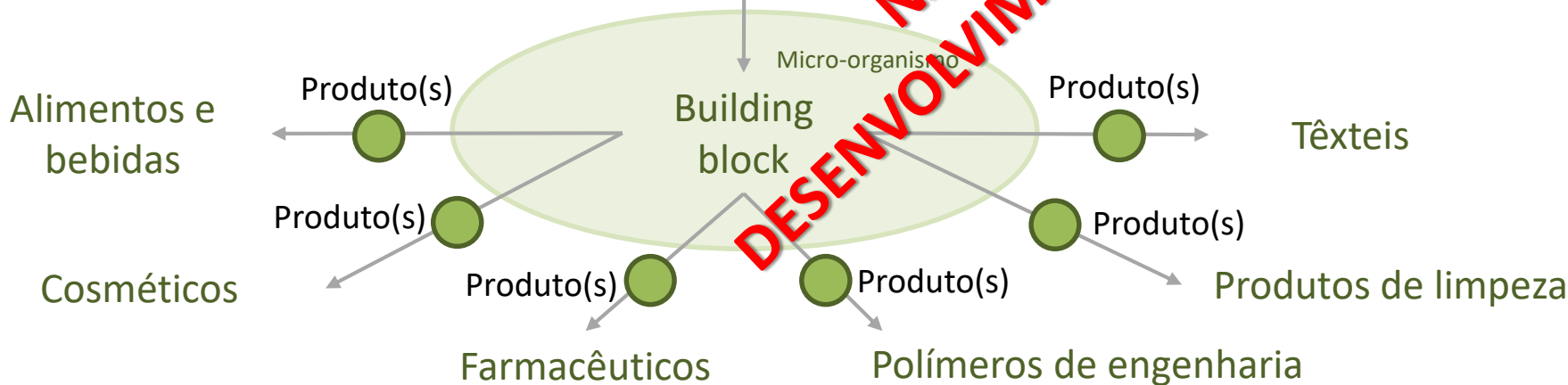
Produtos de Alto rendimento...



- Detergentes
- Produtos de cuidados pessoais
- Agroquímicos



Novas Plataformas Metabólicas...



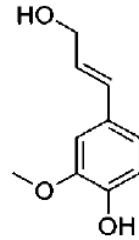
NÃO "DROP IN"
DESENVOLVIMENTO DE APLICAÇÃO

Produtos a Partir da Lignina...



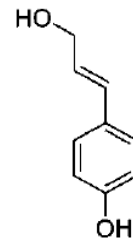
Fermentação em estado sólido

Álcool coniferílico



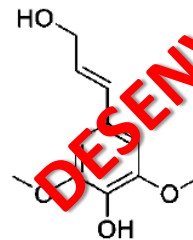
coniferyl alcohol

Álcool p-cumarílico



p-coumaryl alcohol

Álcool sinapílico



sinapyl alcohol

Intermediários

DESENVOLVIMENTO DE APLICAÇÃO

- Possibilidades:
- Aromas e fragrâncias
 - Farmacêuticos
 - Polímeros
 - Surfactantes



AGENDA

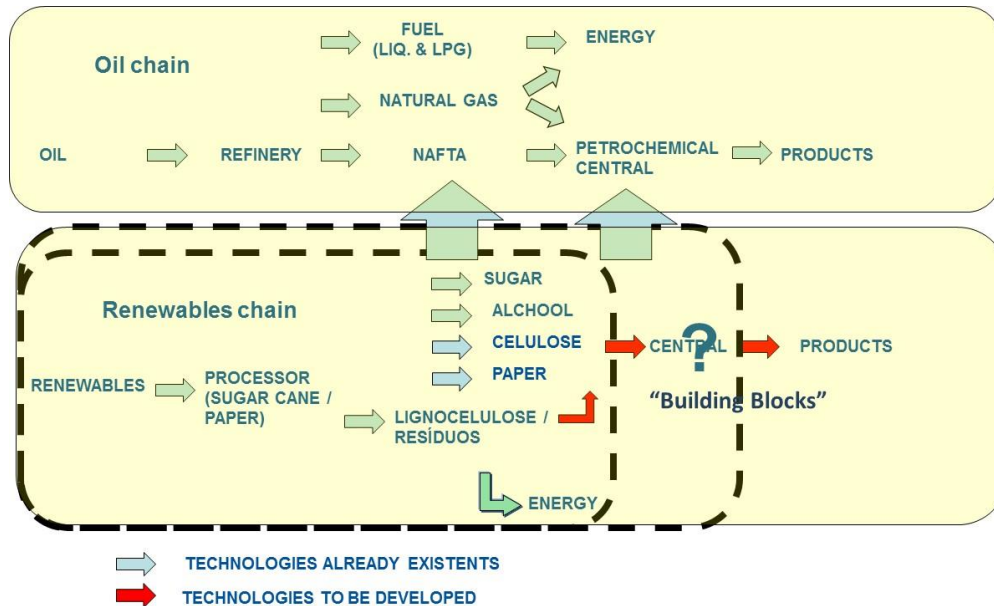
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Conclusões

- ✓ **Megatendências e Tecnologias** em evidência devem ser observadas na **definição de estratégias e produtos**
- ✓ **Biotecnologia, Nanotecnologia, Intensificação de Processos e os avanços na Computação** promoverão **mudanças** significativas em processos e produtos nos próximos anos;
- ✓ **Químicos Renováveis Competitivos** pressupõem **alto rendimento** em relação as matérias primas
- ✓ **Alto Rendimento** pressupõem **uma nova Química, novas Moléculas, Novos Materiais**
- ✓ **Desenvolvimento de Aplicação** é atividade **primordial**;
- ✓ Estratégia deve contemplar a introdução do Mercado de **novas especialidades** (mais fácil – performance). Exs: AMYRIS, RIVERTOP vs REVERDIA

Conclusões

- ✓ A unidade de papel e cellulose já constitui uma biorefinaria;
- ✓ Qual o Modelo de Biorefinaria futura da Indústria de papel e Celulose?
Onde estão os desafios?



- ✓ Posição do setor parece mais efetiva (não está preso a commodities / drop in). Paradigma Custo/Escala/Cultura reduzido;
- ✓ Estratégia ainda não definida;
- ✓ Parcerias com grandes empresas Químicas poderia acelerar o processo? (REVERDIA-DSM/ROQUETE; SUCCINITY-BASF/PURAC; VINITHAY-SOLVAY/PTT...)

“We live in an age where everything is possible, and nothing is certain.” - Vaclav Havel

“Science can amuse and fascinate us all, but it is engineering that changes the world.” - Biochemist and novelist Isaac Asimov

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