



**Prof Michel DELMAS**

# WOOD RESIDUES AS FEEDSTOCK FOR THE 2G BIOLIGNIN BIOREFINERY

**SWST meeting / June, 08, 2015**

# LIGNIN and BIOLIGNIN™



- A current adage from the pulp and paper industry:

**“ YOU CAN DO ANYTHING WITH LIGNIN EXCEPT MONEY”**

- A new one with BIOLIGNIN™, the trade mark of lignin extracted with the CIMV technology:

**“ YOU CAN DO A LOT OF THINGS WITH BIOLIGNIN™ IN PARTICULAR MONEY”**

**It is not a joke but a reality shared with a lot of Universities and Companies working with us in European Union granted programs**

# CIMV European Programs



The EU project BIOCORE will conceive and analyse the industrial feasibility of a biorefinery concept that will allow the conversion of cereal by-products (straws etc), forestry residues and short rotation woody crops into a wide spectrum of products including 2nd generation biofuels, chemical intermediates, polymers and materials.

- Duration: 48 months project (end Feb 14)
- Project Funding: 13,8 M€
- 24 partners from 13 Countries



The BIO-MIMETIC project will generate a new class of bio-inspired polymers via extraction of natural compounds from renewable resources.

- Duration: 36 months project (end Aug 15)
- Project Funding: 3,5 M€
- 10 partners from 6 European Countries



The INNOBITE project will transform urban and agricultural residues into high performing, resource efficient products for the emerging Green Construction sector.

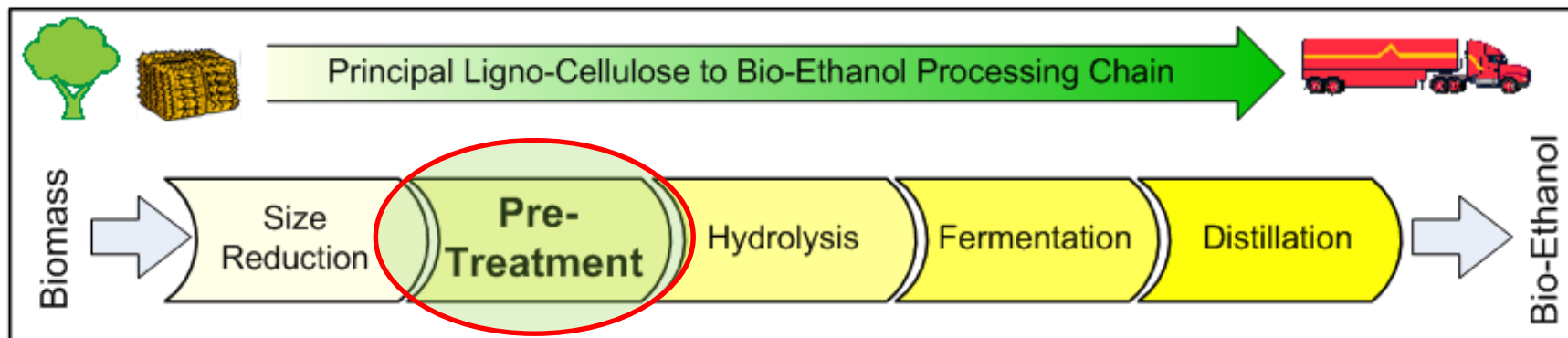
- Duration: 36 months project (end Sept 15)
- Project Funding: 3,2 M€
- 9 partners from 6 European countries

A close-up photograph of green leaves with several clear water droplets on their surface. The background is a bright blue sky, creating a bokeh effect with out-of-focus light spots. The image is partially obscured by a dark green horizontal bar at the top.

# CIMV TECHNOLOGY

# CIMV 2G2 Advanced Technology

**The CIMV advanced 2G Biorefining stand out from 2G biorefining processes  
By the original pretreatment process**



***Processing steps in lignocellulose to bioethanol production***

***In the biorefining Industry, the Pretreatment is the key step for the extraction of components of biomass.  
Efficiency of downstream treatments, yield and quality of products depend on the pretreatment.***



# CIMV 2G Advanced Biorefining

## A multi feedstock technology

More than Euros **40 M investment** into R&D since 2005  
**Extensive studies on hard wood, cereal straws etc...**  
and supply chain logistics investigation

**Intellectual Property** 10 patent families applications filed,

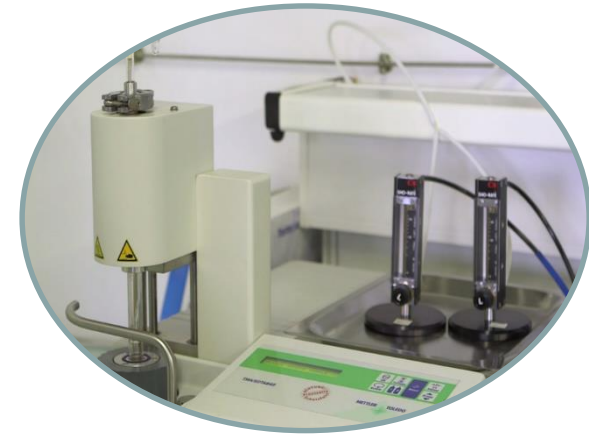
**Focus on :**

**2G Glucose and Xylose**

**Bioethanol**

**Biolignin™**

**And bio-based chemicals**



# CIMV Pilot Plant



**Biomass pretreatment**



**Hydrolysis & fermentation**



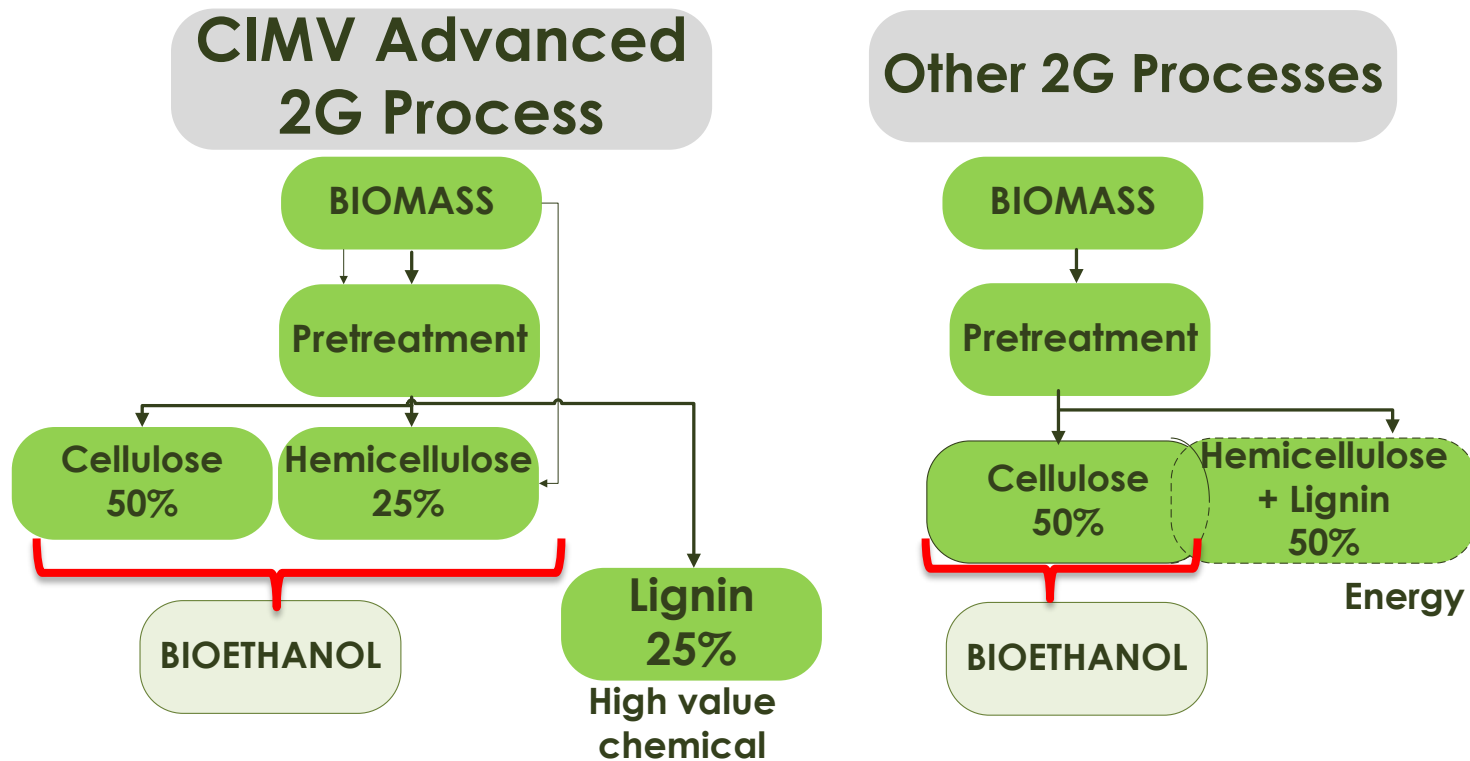


## Clean, efficient and profitable



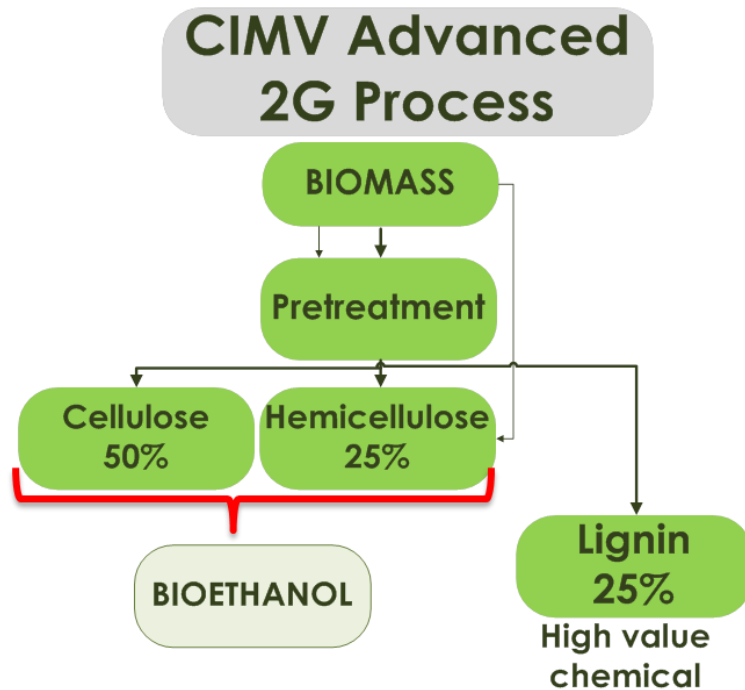
- Valorization of the overall input
- Low water consumption
- Solvent recycling
- No waste

# The difference with competitors



# CIMV 2G2 Advanced Technology

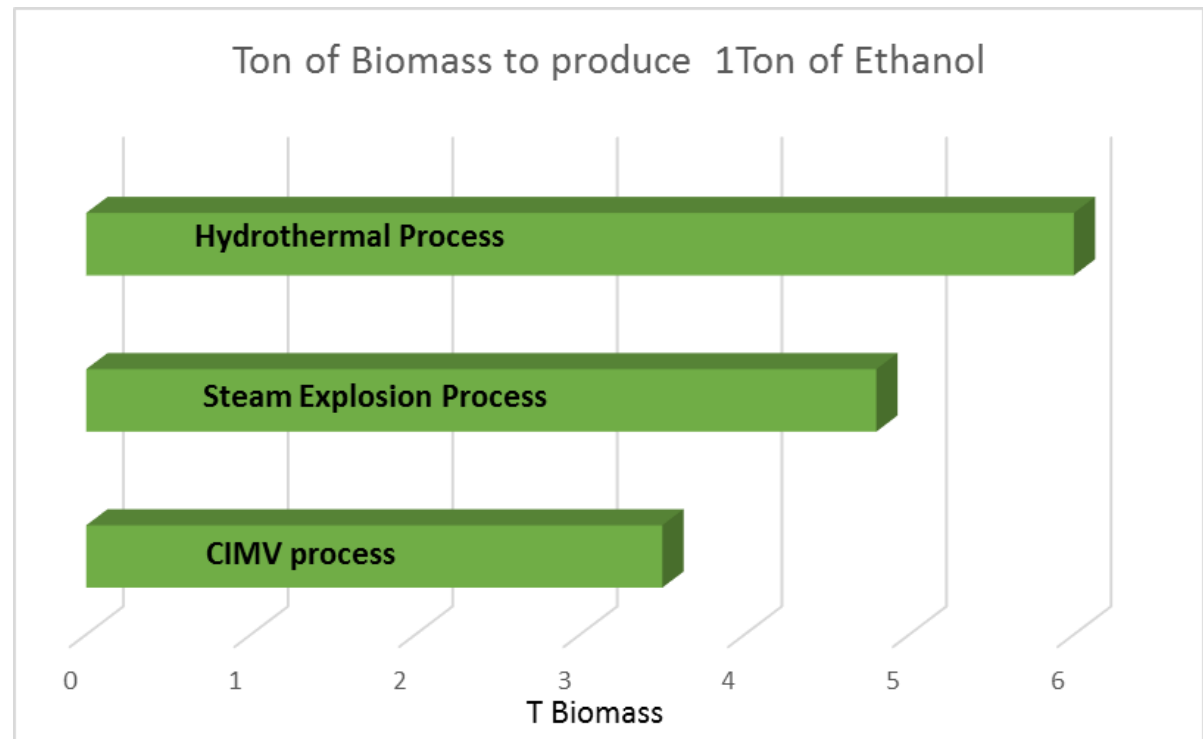
## CIMV Technology breakthrough



Pretreatment process is soft conditions  
(100°C, Patm) :

- **high yields:** 98 % of the biomass is valorized;
- **high purity:** *clean product available for chemistry*;
- **no degradation :** availability of a high value lignin : the Biolignin™;

## Efficient Technology





A close-up photograph of green leaves with several clear water droplets on their surface. The background is a bright blue sky, creating a bokeh effect with out-of-focus light spots. The image is split horizontally, with the top half showing a blurred view of the leaves and the bottom half showing a sharper view of the water droplets.

# CIMV ROADMAP



# CIMV PROCESS™ SCALE-UP :

## SCALE UPFACTORS



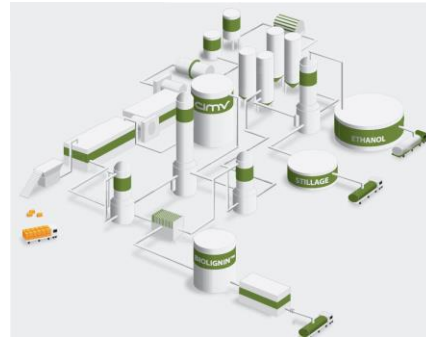
**LABORATORY**

1 kg/h Biomass



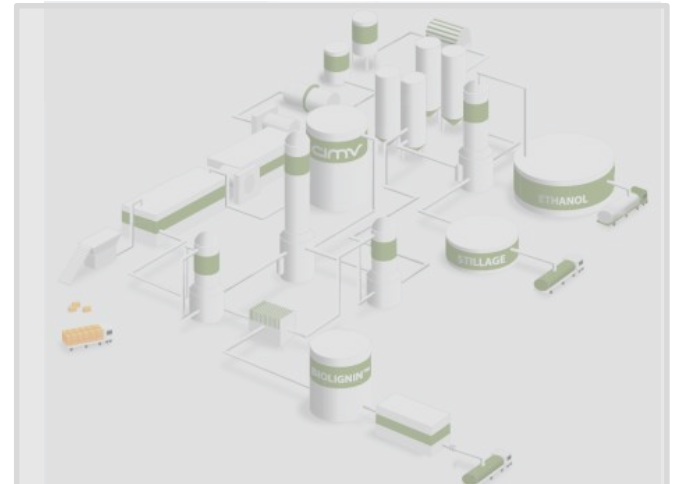
**PILOT PLANT**

50 kg/h Biomass



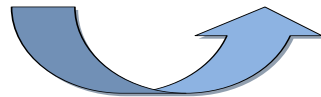
**DEMONSTRATION  
PLANT**

1 T/h Biomass



**INDUSTRIAL PLANT**

50 T/h Biomass



**x 50**



**x 20**

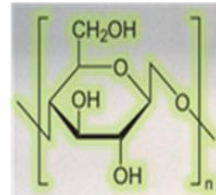


**x 50**

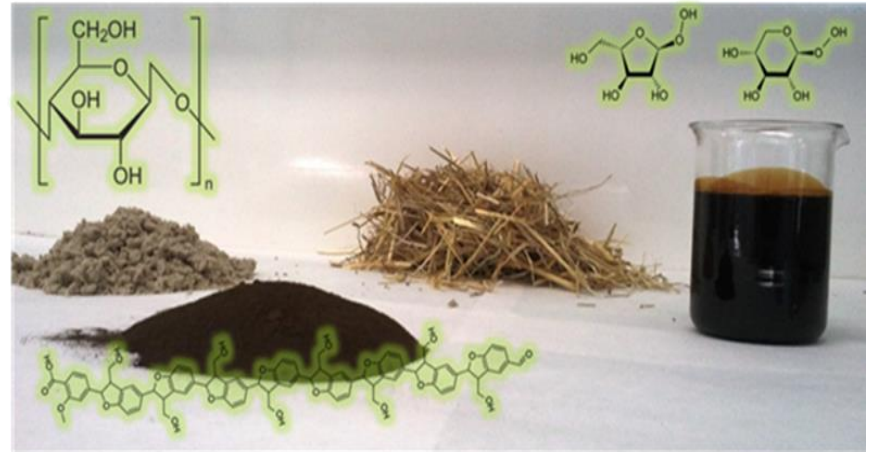
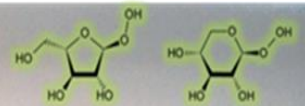
# CIMV PRODUCTS



Cellulose and glucose



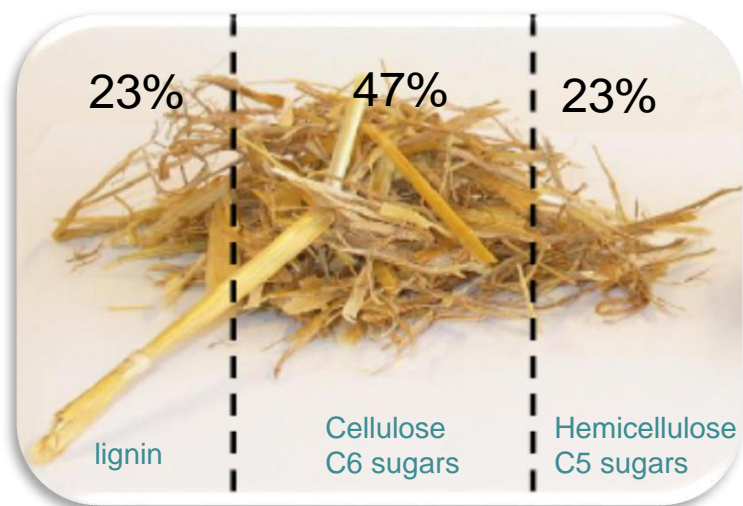
Pentose sugars



Lignins

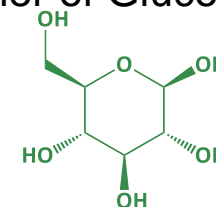
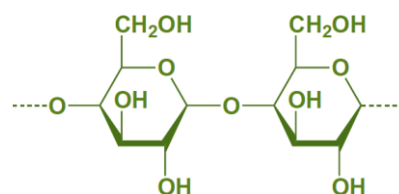
# CIMV 2G 2 Main Products

## Non-food Biomass is a Renewable Source of Carbon for Bio Based Fossil Fuel Substitutes

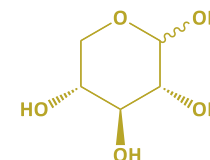


*3 / 7 % of silica, mineral and organic products*

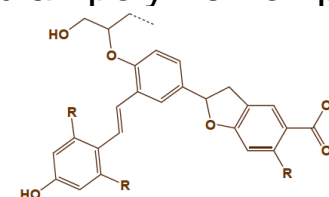
– **Cellulose** is a regular polymer of Glucose.



– **Hemicelluloses** are amorphous polymers of C5 sugars mainly Xylose



– **Biolignin™** is a regular polymer of phenolic monomers

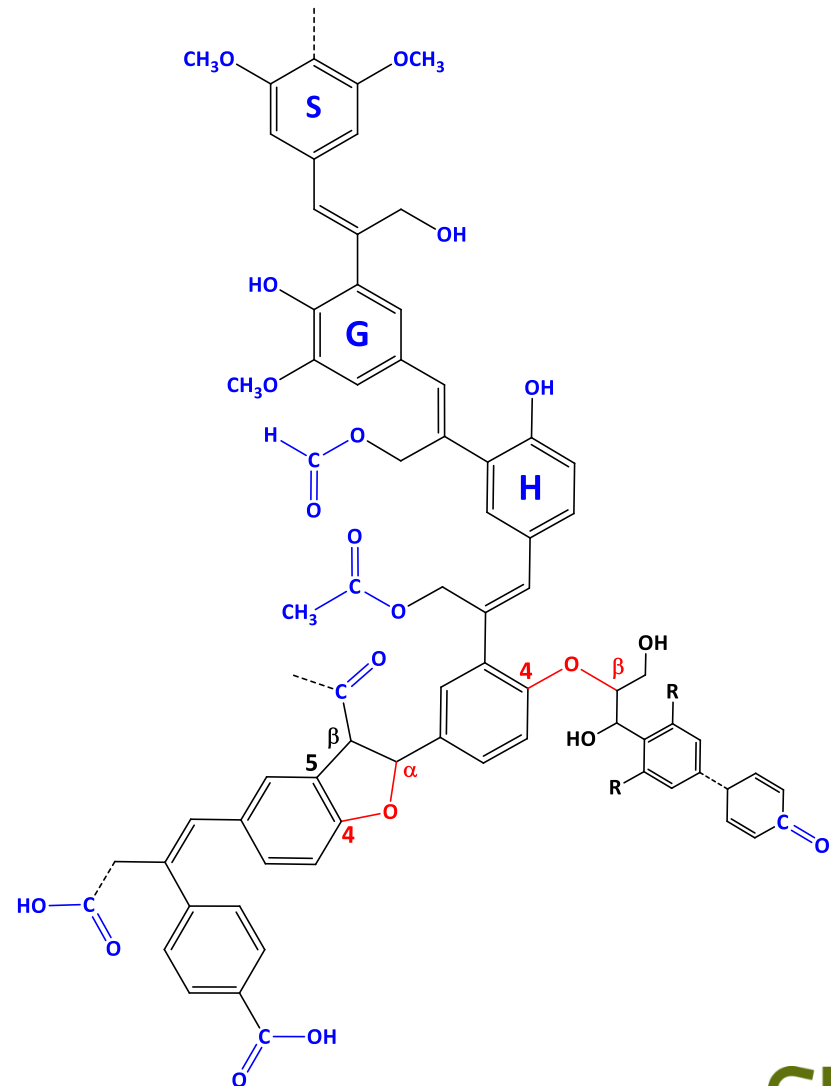


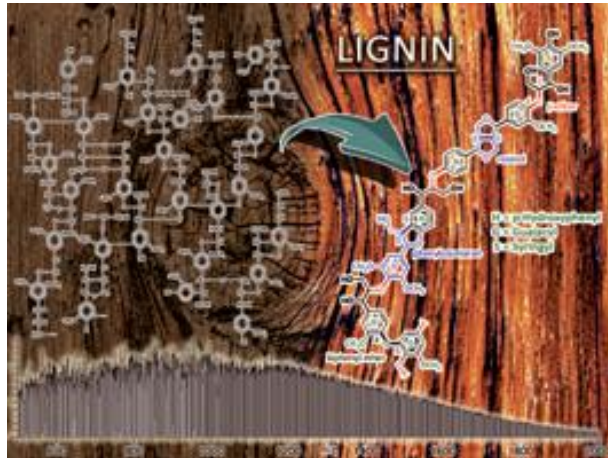
Biolignin™ trade mark by CIMV



# BIOLIGNIN™ STRUCTURE

- A perfectly identified structure
- Free phenol groups
- Partially esterified hydroxymethyles groups
- A terminal carboxylic function
- No strong covalent bond with polysaccharides
- A new easy handling commodity for the chemical industry





Front page of the 2015 first issue

► A critique on the structural analysis of lignins and application of novel tandem mass spectrometric strategies to determine lignin sequencing

By J. Banoub, G-H. Delmas Jr., N. Joly, G. Mackenzie, N. Cachet, B. Benjelloun-Mlayah and M. Delmas , *Journal of Mass Spectrometry*, 2015, 50, 5–48

<http://onlinelibrary.wiley.com/doi/10.1002/jms.3541/abstract>

► on you can see the difference between the VRL( Virgin Released lignins ) and the PRL '( Process Modified Lignins)

Journal of  
**MASS  
SPECTROMETRY**

# BIOLIGNIN™ Applications

- Phenolic resins
- Polyurethanes coating and foams,
- Epoxy resins
- Carbon black substitute in Rubbers

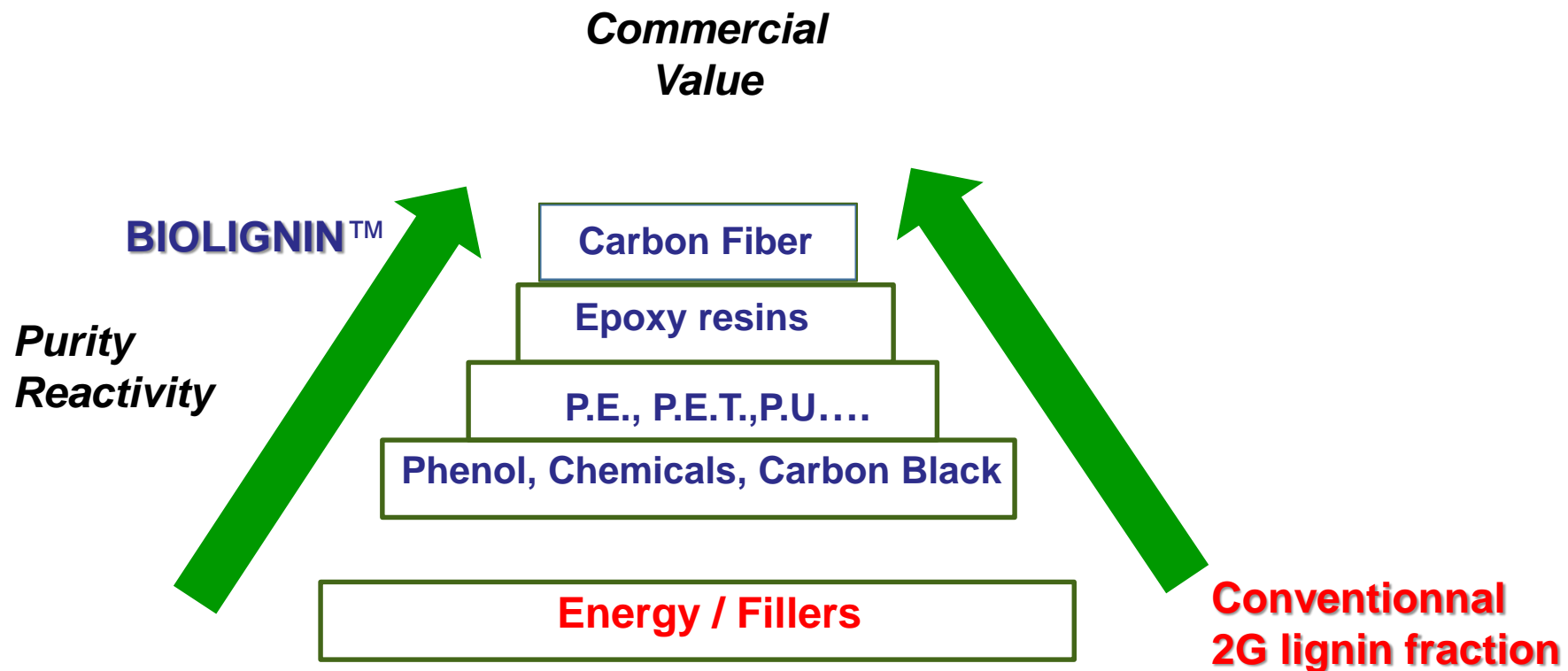


## Advantages

- substitution of phenol in PR (50 to 80% substitution rate)
- Substitution of polyols PU (40 to 60%)
- Substitution of carbon black in Rubbers ( 50 to 100%)
- Direct use of a biobased chemical in the Industry.

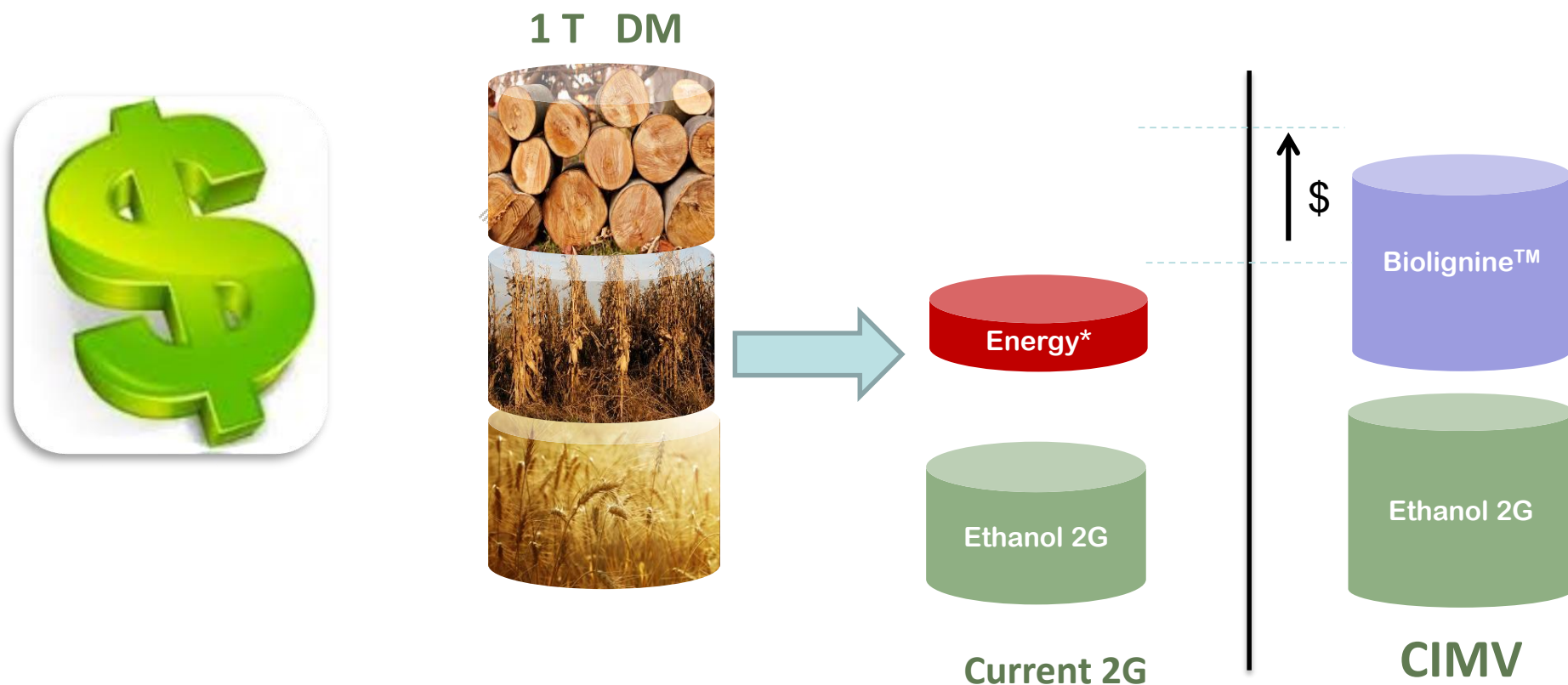
# CIMV Biolignin™ or how to make money with lignin

## Maximum Monetization of the lignin fraction



# CIMV : Bioethanol and Biolignin™

## Maximum monetization vs competitors



\* Without subsidies

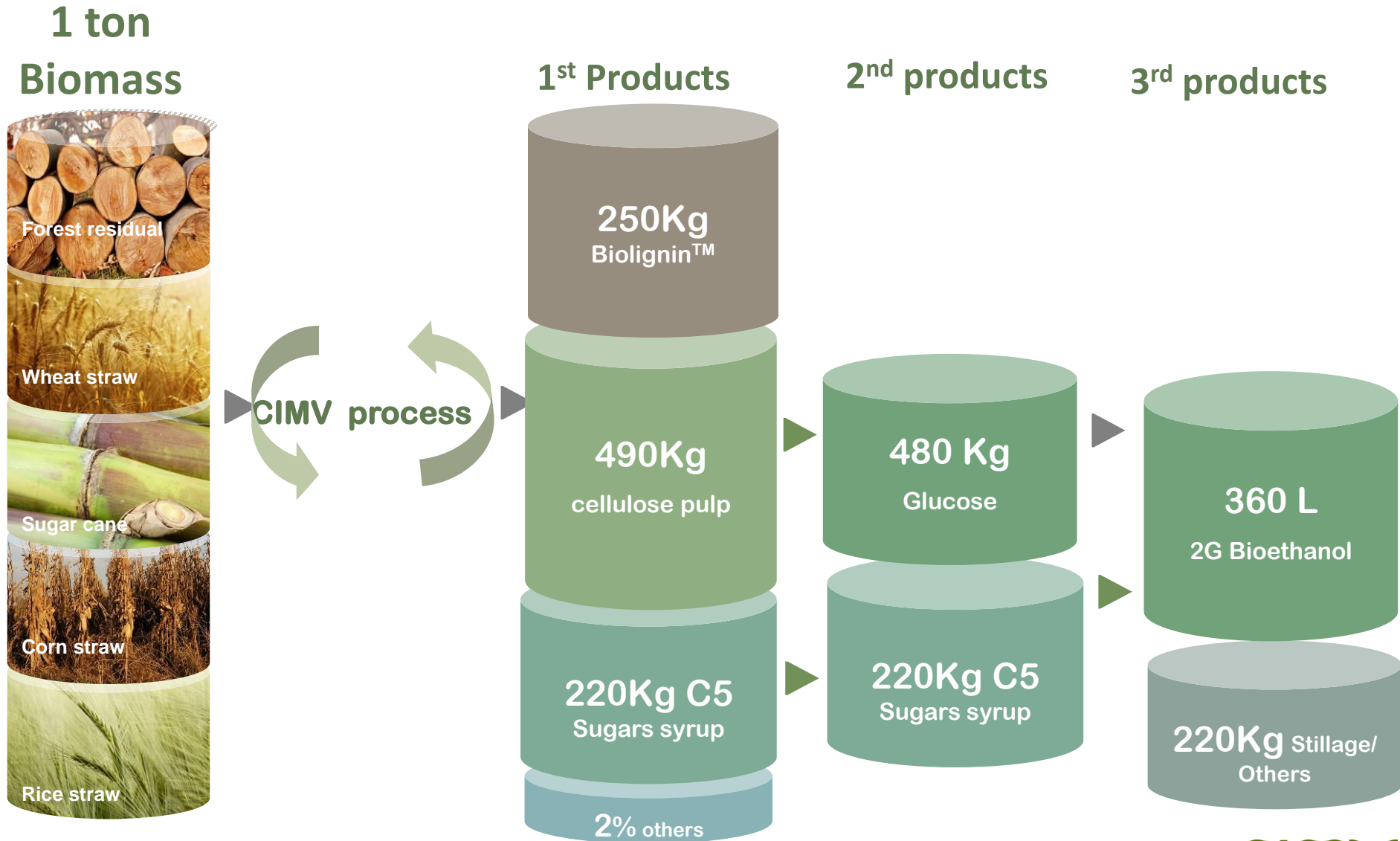


# CIMV 2G 2 process and the current competitors

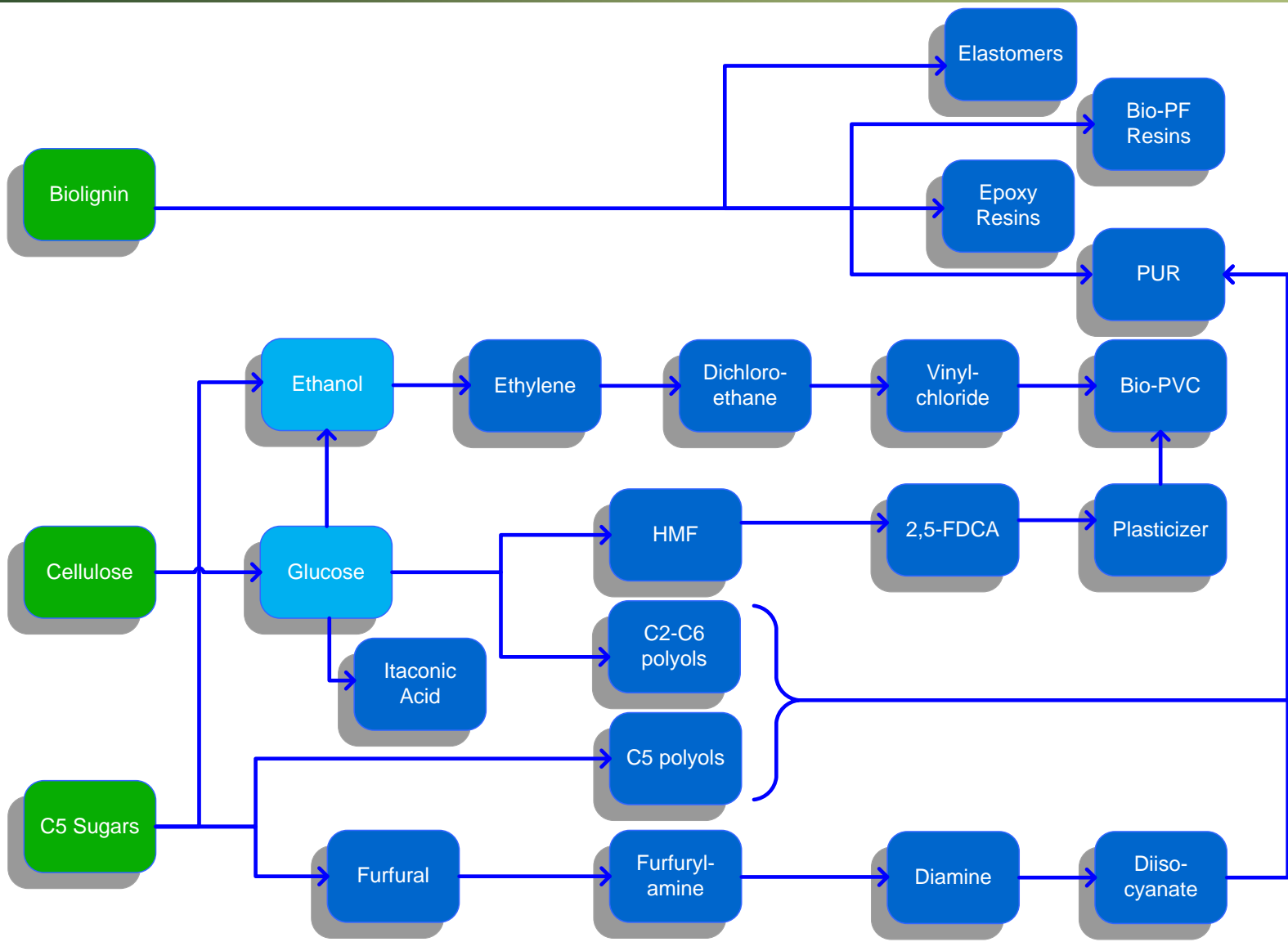
## Outputs of the Biorefining Process

	Current 2G	CIMV 2G2
Ethanol Yield / Ton Input	240 l	360 l
High value Lignin yield/Ton Input	X	250 kg
Low value Lignin Yield / Ton Input	350Kg	X
Total Revenue / Ton Input	230 \$	560 \$
Total Feedstock Cost / Ton	60 \$	60 \$
Total Processing Cost / Ton Input	183 \$	333 \$
Total Profit Opportunity / Ton Input	-18 \$	166 \$

# PRODUCTS YIELDS



# DIFFERENT INVESTIGATED ROUTES



# DEMONSTRATION PLANT



# CIMV DEMONSTRATION PLANT PROJECT

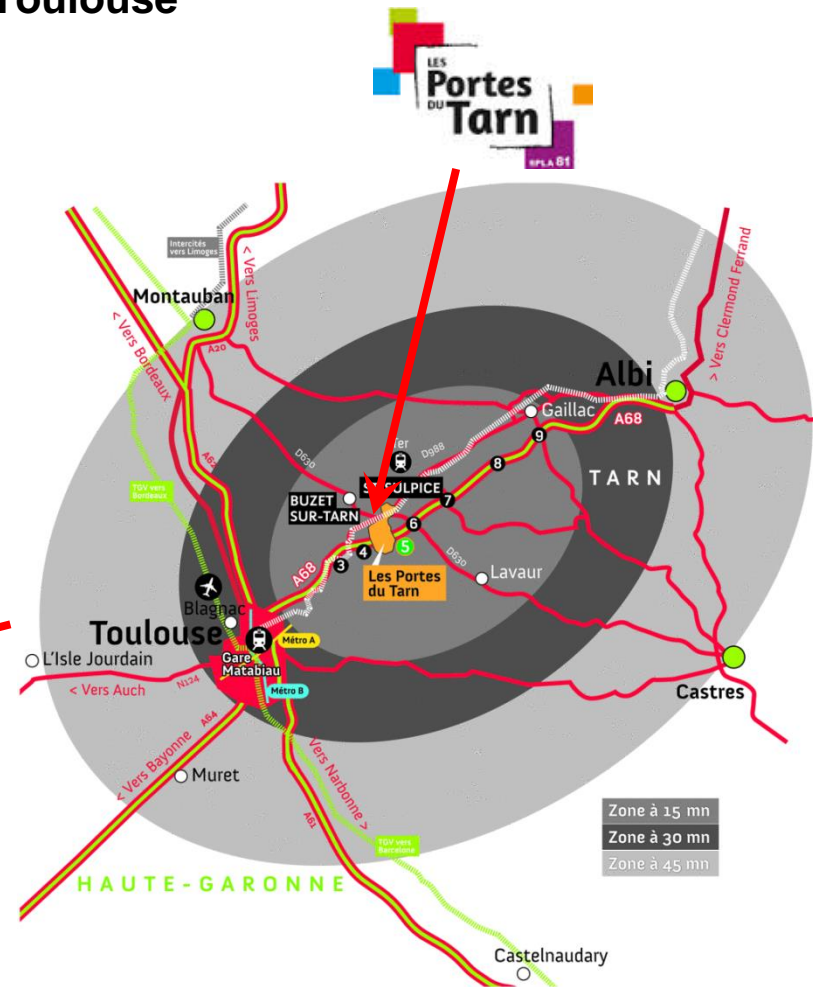
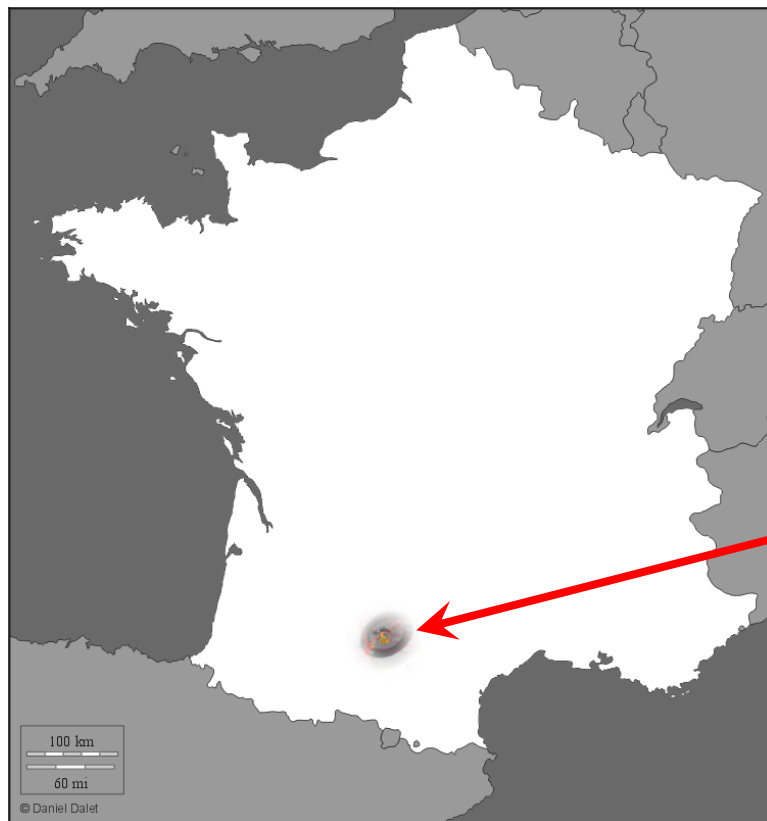
- **Location: South West of France – Toulouse area**
- **Capacity: 1t/h Biomass**
- **Feedstock: wheat & barley straw, corn stover, wood, sugar cane bagasse...**
- **Outputs : Pulp/Glucose/Ethanol + C5 Syrup + Biolignin™**
- **Output capacity / year:**  
**Glucose (1,500 t)/Ethanol (700 t) + C5 Syrup (650 t)+ Biolignin™ (750 t)**



# DEMONSTRATION PLANT

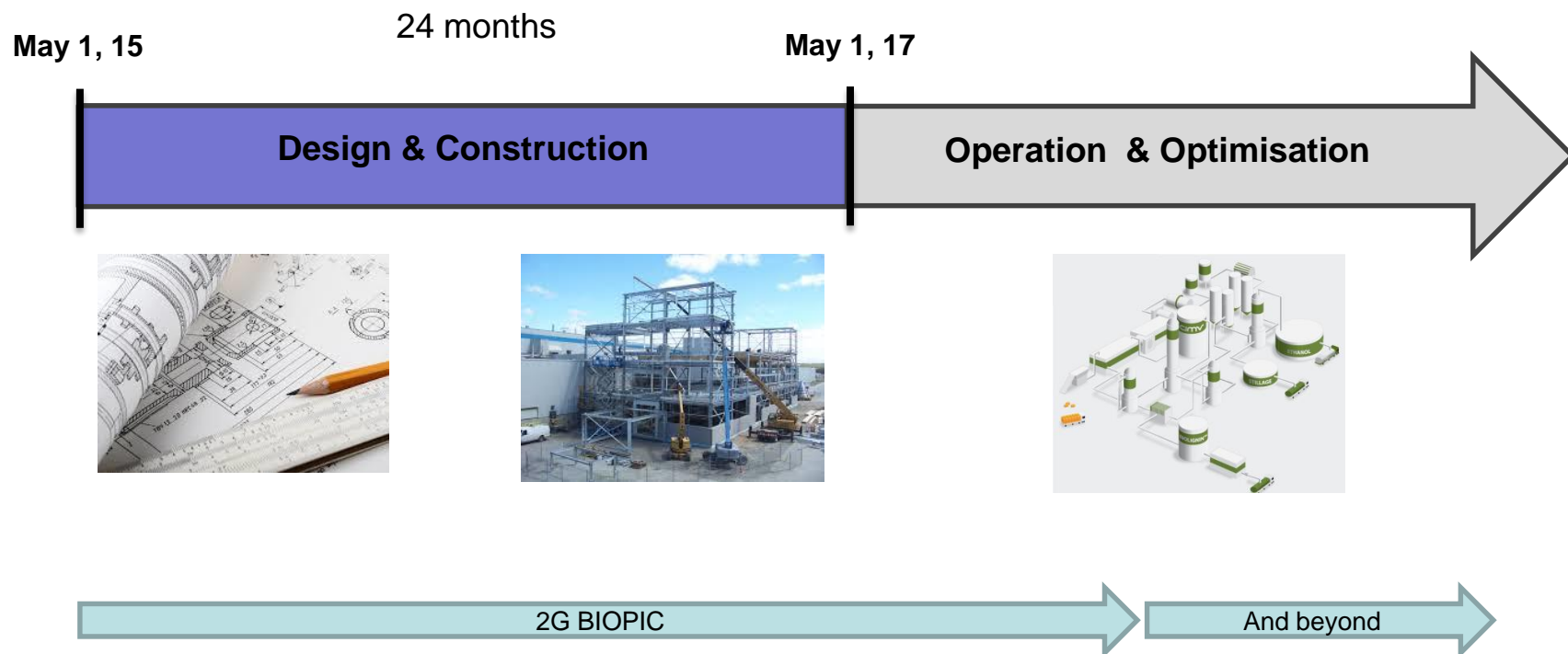
## Localization

20 Km NW of Toulouse



# DEMONSTRATION PLANT

## Schedule

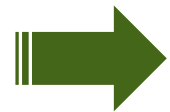




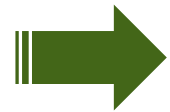
## 2G BIOPIC -



**Total Program Costs 56 M €**



**European Commission Subsidy : 20 M €**



**7 Partners : CIMV (Coordinator) DYADIC, ROLKEM,  
TAURUS, INSAT, TWB, BBEPP**



***An open private sugar platform for further  
partnership and opportunities***



Thank you