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## Lignins-first flexible biorefinery: design of an integrated valorization process

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# Lignins-First Flexible Biorefinery: Valorization Process

## Design for Sustainable Construction Material

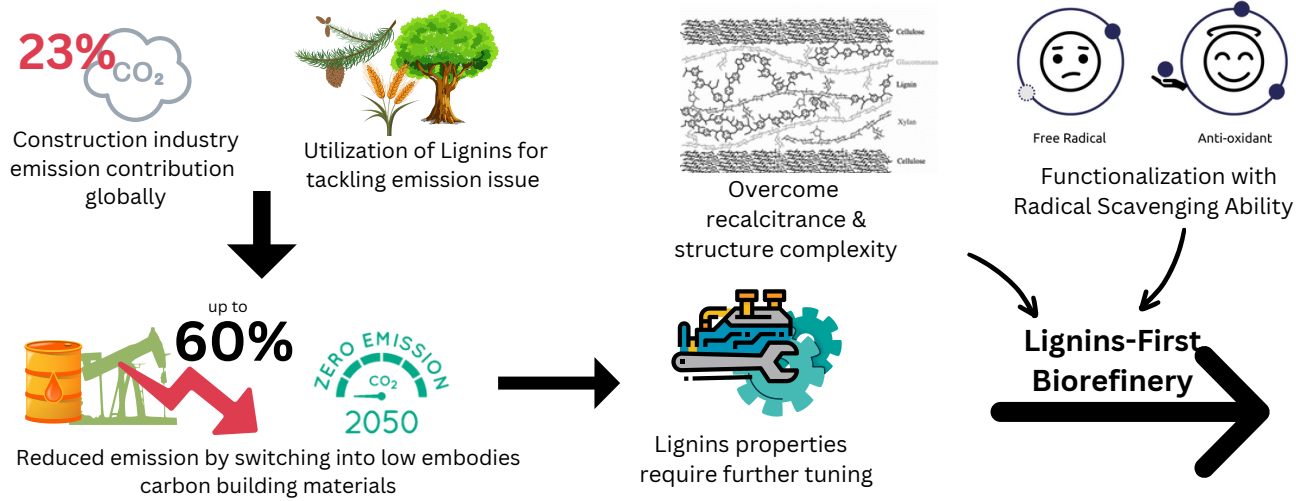
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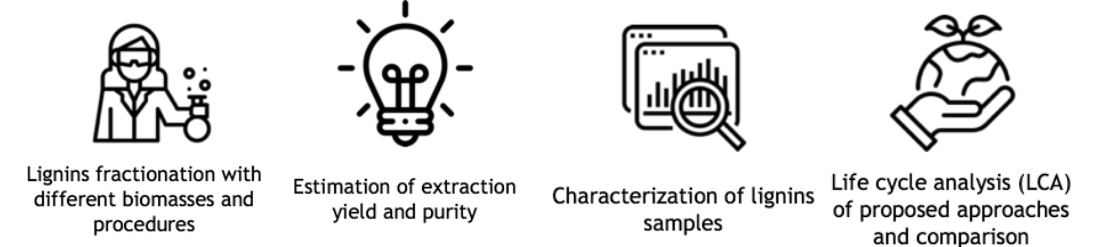
AgroParisTech, University of Paris-Saclay<sup>1</sup>; Tallin University of Technology<sup>2</sup>; University of Reims Champagne-Ardenne<sup>3</sup>



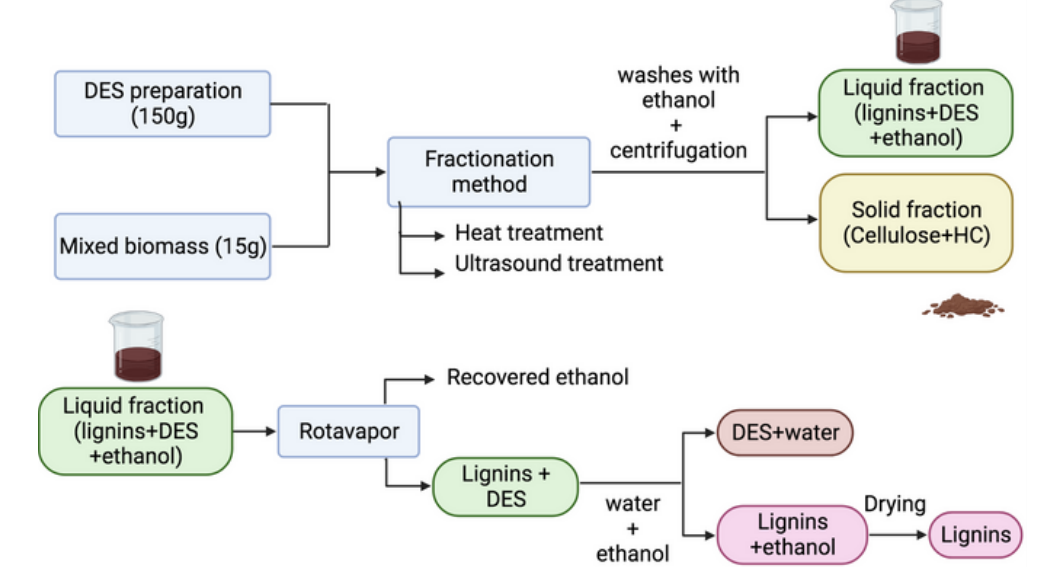
### Introduction



### Objectives and Experimental Plan



### DES Fractionation Treatment

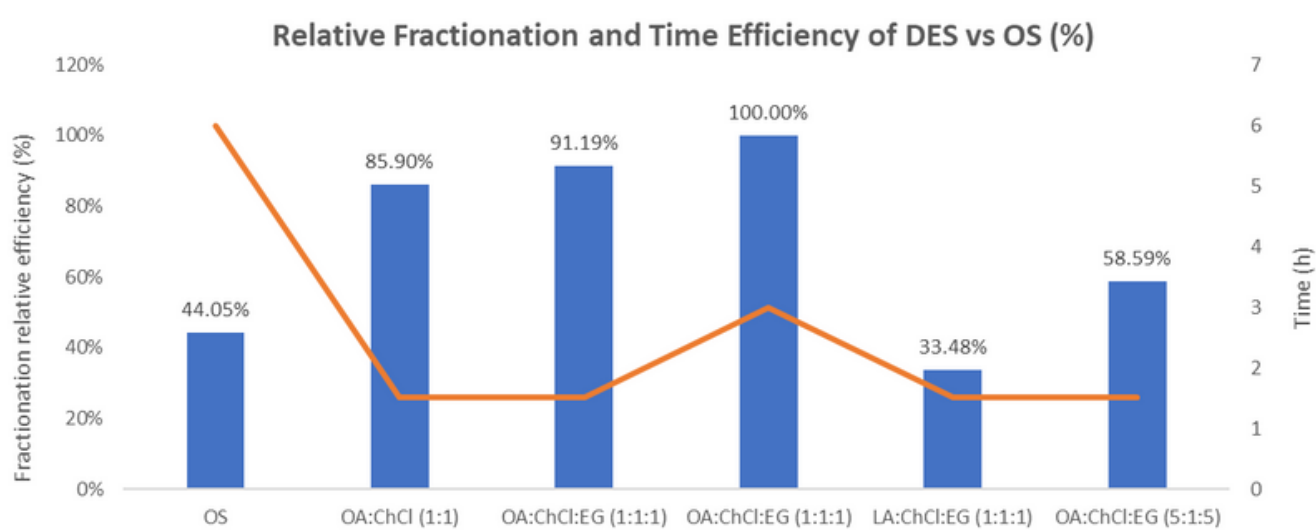


### Results Analysis

#### Flexibility through the integrated approach

- Fractionation similar rates for mixed biomass and individual biomasses (95.44%)
- Lower Mw obtained through an integrated approach
- Wider range of available products with mixed biomass fractionation

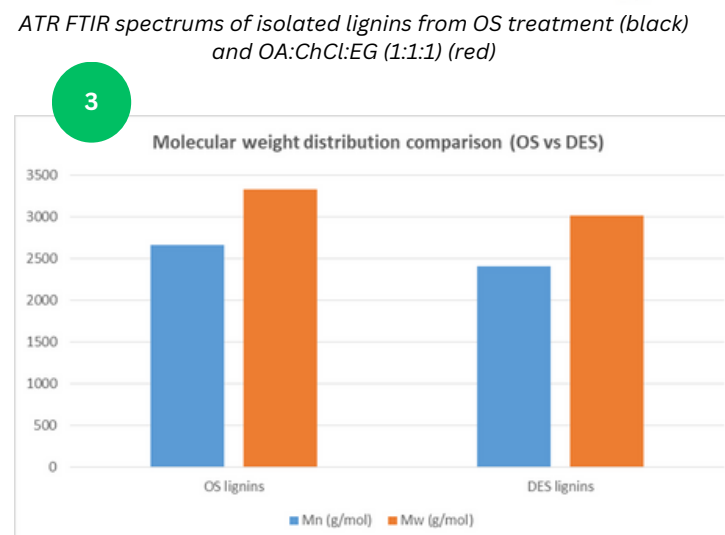
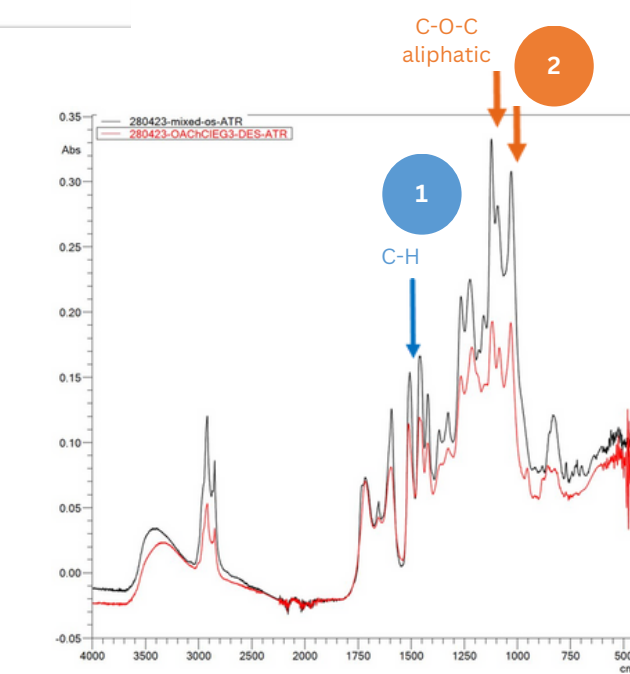
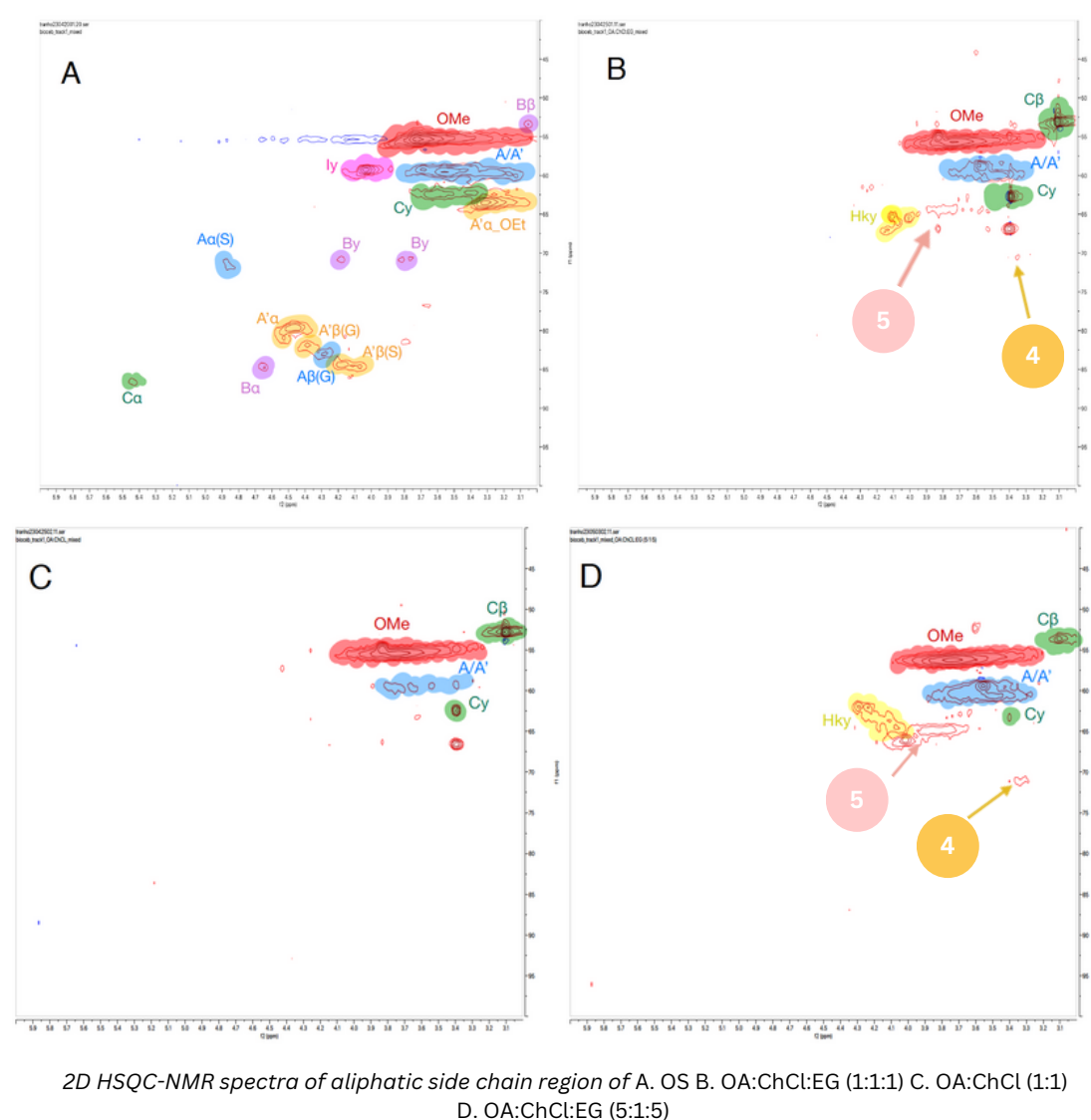
#### Relative performance of DES fractionation of the biomass



- The considerable drop in duration period and increase in the relative fractionation efficiency set DES as the preferred treatment for lignins isolation.
- While DES lignins present "thinner" grains and darker colors, OS lignins were found much "rougher" and lighter colors. This can be doomed in the former case's acidity conferred by the employed solvent.
- Different fractionation treatments presented distinct textures and colors when comparing OS and DES-isolated lignins.



### DES effect on Isolated Lignins



#### B-5 conserved

- Little reduction in C-H bond availability in DES-treated lignins. It shows the B-5 bond is less likely to be cleaved in DES treatment

#### B-O-4 Selective Cleavage

- A significant drop is observed in C-O-C aliphatic region. It emphasized that the B-O-4 bond is selectively cleaved to prevent C-C bond cleavages (B-5, B-8, or 5-5") leading to less condensation.

#### Molecular Uniformity & Weight Distribution

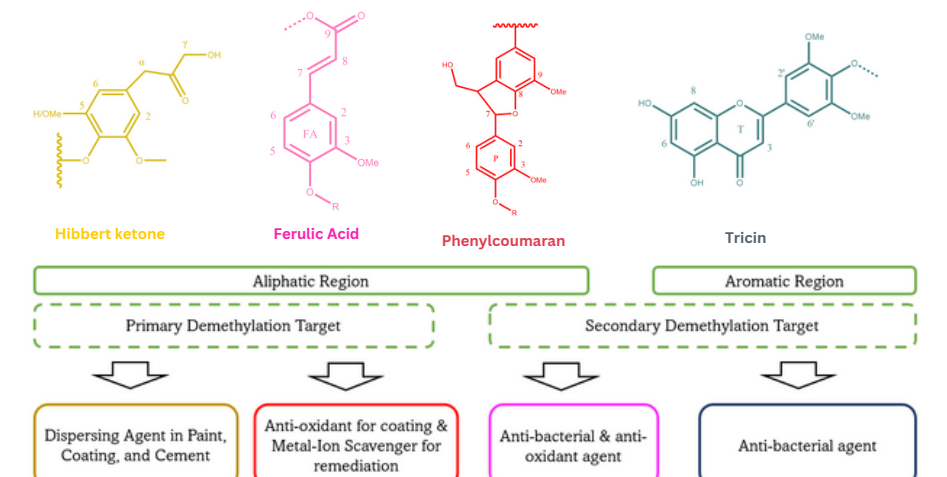
- The Mn of lignins from DES treatment is comparatively lower than OS due to smaller oligomers possibly found with a lower polydispersity index. It indicates that DES oligomers or monomers are more consistent in terms of molecular size and weight. Additionally, lower Mw are identified for the DES isolation of lignins.

#### Stabilizer Signal

- Comparing to current research's result, there is small signals on 70.20/3.32 (A"-EG/A"-GLY) in OA:ChCl:EG 1:1:1 and 70.64/3.34 for OA:ChCl:EG 5:1:5 2D NMR results which are believed as EG traces.

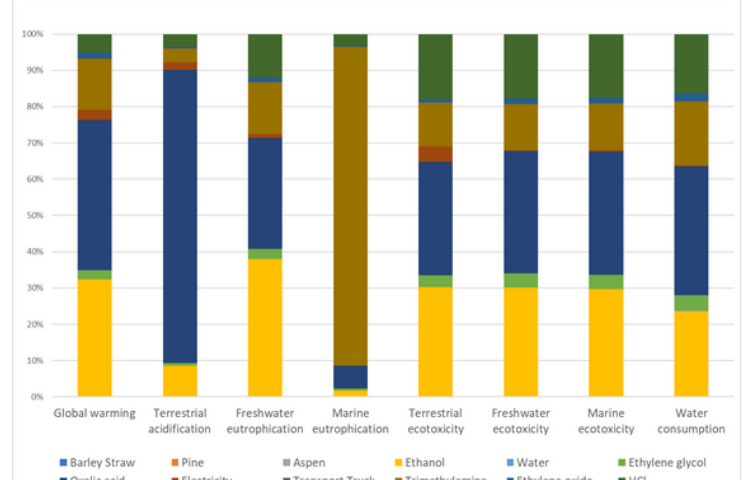
#### Novel Chemical Bonds Formed by EG Stabilization

- These keeper signals were attributed to polyol-incorporated B-O-4 structures. During the fractionation, the acidic DES forms carbocation intermediates via dehydration at the Ca position of lignin. Then, the carbocation intermediate was trapped by the EG to generate polyol-alkoxylated lignins.

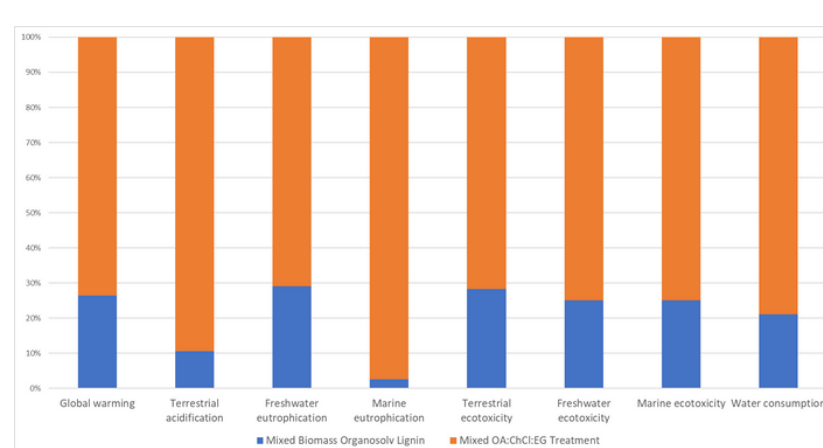


### Life Cycle Assessment

#### Relative Distribution of Impact Analysis on DES Inventory

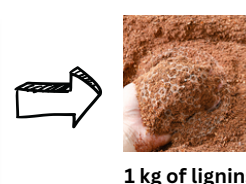


#### Comparison on LCIA Relative Distribution



#### Main Footprints from Respective Treatments

OS	DES
24.6 kg CO <sub>2</sub> eq	68.53 kg CO <sub>2</sub> eq
224 L	840 L



### Future Perspectives

- Depolymerization of isolated lignins through microbial approaches.
- Estimation of the further effect of functionalization on abundance of hydroxyl group on lignins product

### Conclusions

- Flexibility approach through implementation of the integrated approach; not only access to wider amount of interest molecules, but also fractionation of lower MW lignins
- Lignins-first through DES fractionation approach: performance with higher fractionation and time efficiency rates when compared to OS results
- Simultaneous fractionation and functionalization through ternary DES with EG

Special acknowledgement for their help in the project go for Trần Ho and Pia Jöul

