



Wood products, green resins and chemicals

a new wave of doing things

March 4, 2026 – 9.15 CET

Wood products, green resins and chemicals

a new wave of doing things



8:45-9:15 – Arrival

9:15-9:30 Welcome and keynote – Unlocking Biomass through Fast Pyrolysis – BTG

9:30-10:15 Sustainable Materials for the Modern Construction Sector

 **Engineered Wood Panels (Plywood and MDF) - FORESA Technologies**

 **Modified wood products for outdoor applications - FORECO and INNORENEW**

10:15-10:30 Coffee break

10:30 -11:00 Innovative green chemicals

 **Innovative green chemicals in polyurethanes – AEP Polymers**

 **Innovative green chemicals - Furanic derivatives - TFC**

11:00-11:30 Open discussion and Q&A

End of On-line event

11:30 Visit to the demo structure and products showcase

Building a sustainable & circular economy through innovative, biobased manufacturing lines

Overall Objective

Transformation of existing fossil-based manufacturing lines into new bio-based manufacturing lines. The bio-based products must exhibit similar, or better, mechanical, physical, and chemical properties compared to the existing products, and must be non-toxic and recyclable.



Background NewWave

- NewWave uses ThermoChemical Fractionation as starting point.



Thermo Chemical Fractionation (TCF): “an innovative, disruptive two-step conversion process to transform different bio-resources into sustainable raw materials”.

1. Sustainable biomass residues are converted by fast pyrolysis into a liquid Fast Pyrolysis Bio-Oil (FPBO).
2. The FPBO is fractionated *-based on chemical functionality-* by liquid-liquid extraction yielding a reactive **lignin fraction** and a **sugar-rich fraction**, both being excellent starting materials to produce sustainable, bio-based chemicals & materials.



1. Fast pyrolysis



- W Thermal depolymerisation of organic material in absence of oxygen
- W Main product: liquid bio-oil (FPBO).
- W Typical Process conditions
 - $T = 400 - 600\text{ }^{\circ}\text{C}$
 - $P = \text{atmospheric}$
- W Fast Pyrolysis is commercially available (www.btg-bioliquids.com)
- W Standardized design – capacity 5 t/h dry biomass
- W Delivery of turn-key plants



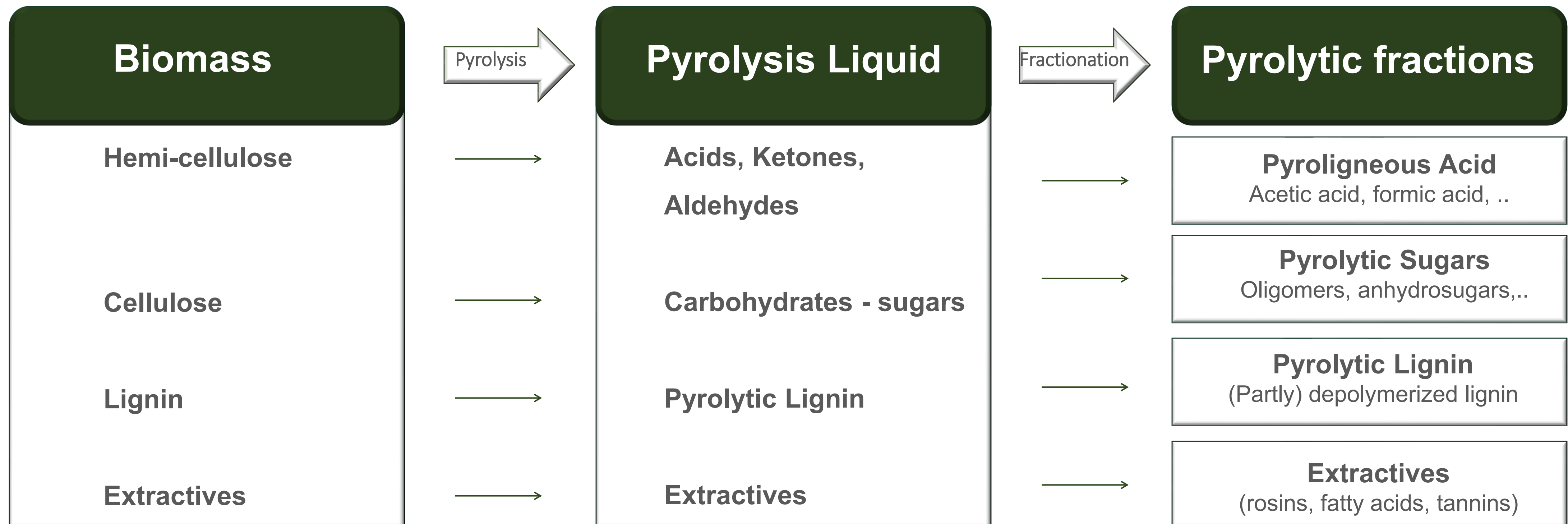
FPBO Production plants



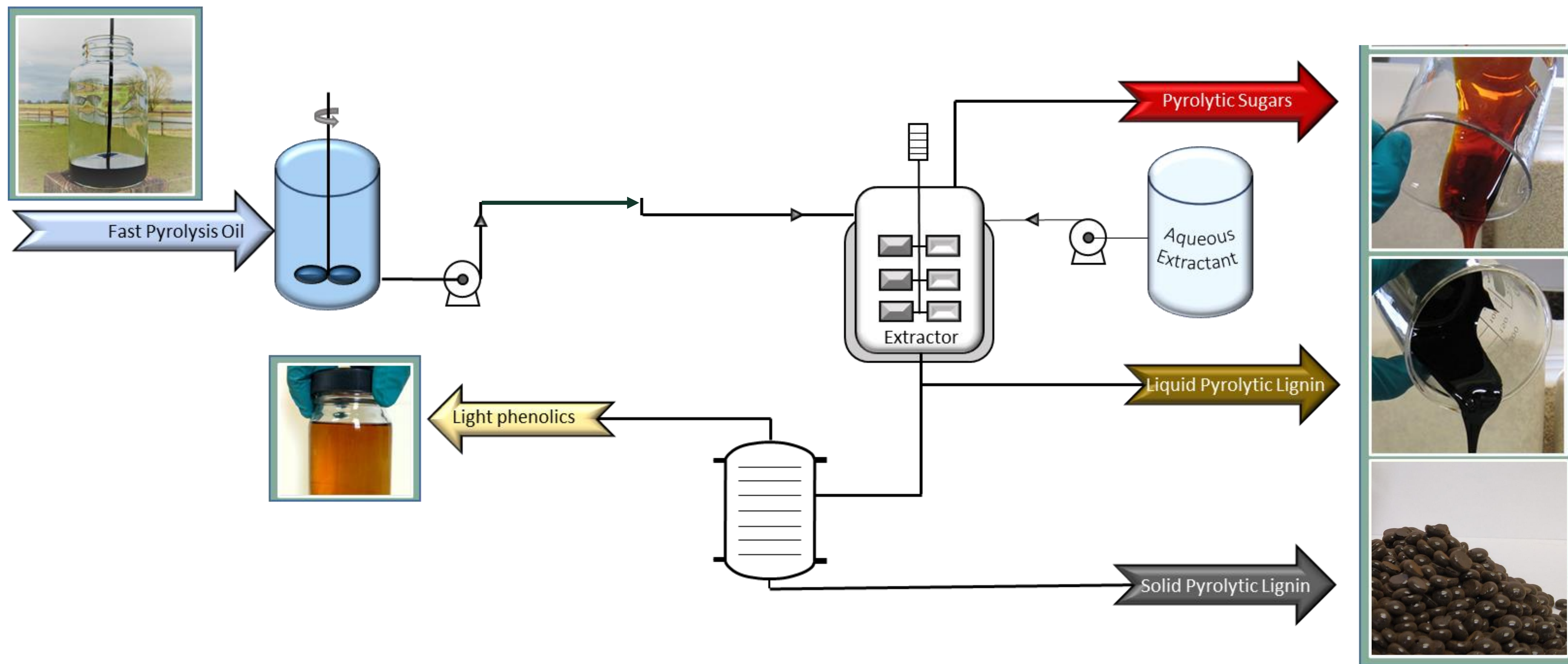
2. FPBO Fractionation



- W Key biomass functionalities retained in the pyrolysis oil!
- W Fractionation process based on liquid-liquid extraction enabling separation on basis of functionality!
- W Each fraction is used directly as raw material in bio-based products or a starting point for further dedicated (electro)-chemical, catalytic or biotechnological conversion.



2. Liquid-Liquid extraction of FPBO



FPBO Fractionation Pilot Plant

- Demo-plant for FPBO fractionation is operational
- Based on liquid-liquid extraction of the whole oil
- Products are: pyrolytic lignin, pyrolytic sugars (& pyrolytic extractives)
- Proven capacity ~120 kg/h FPBO feed
- REACH registration filed for P.lignin and p.sugars (1-10 t/h)

CAS numbers

Pyrolytic sugars: 2414605-13-1

Pyrolytic lignin: 2411004-28-7

Solid Pyrolytic Lignin: 2411004-20-9

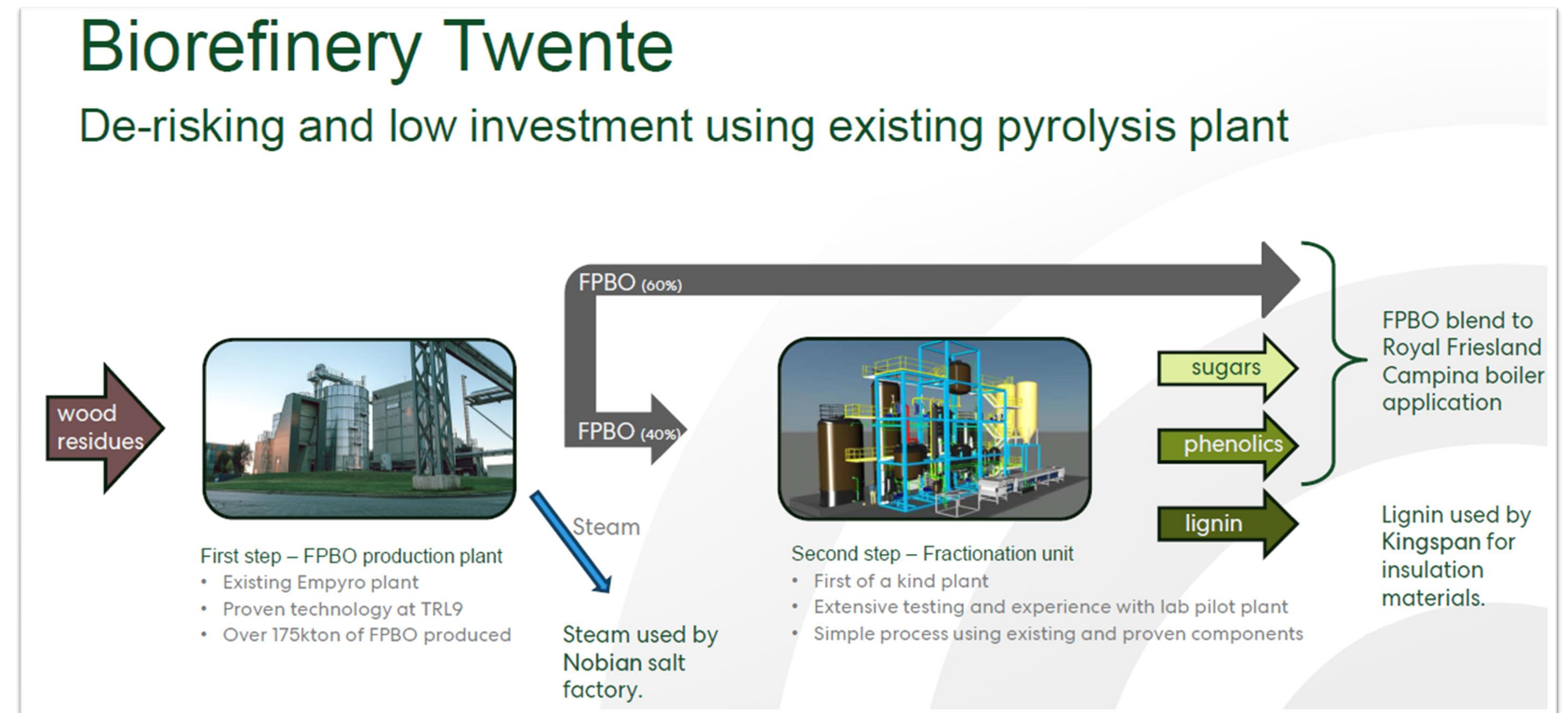


Scaling-up & Value chain demonstration



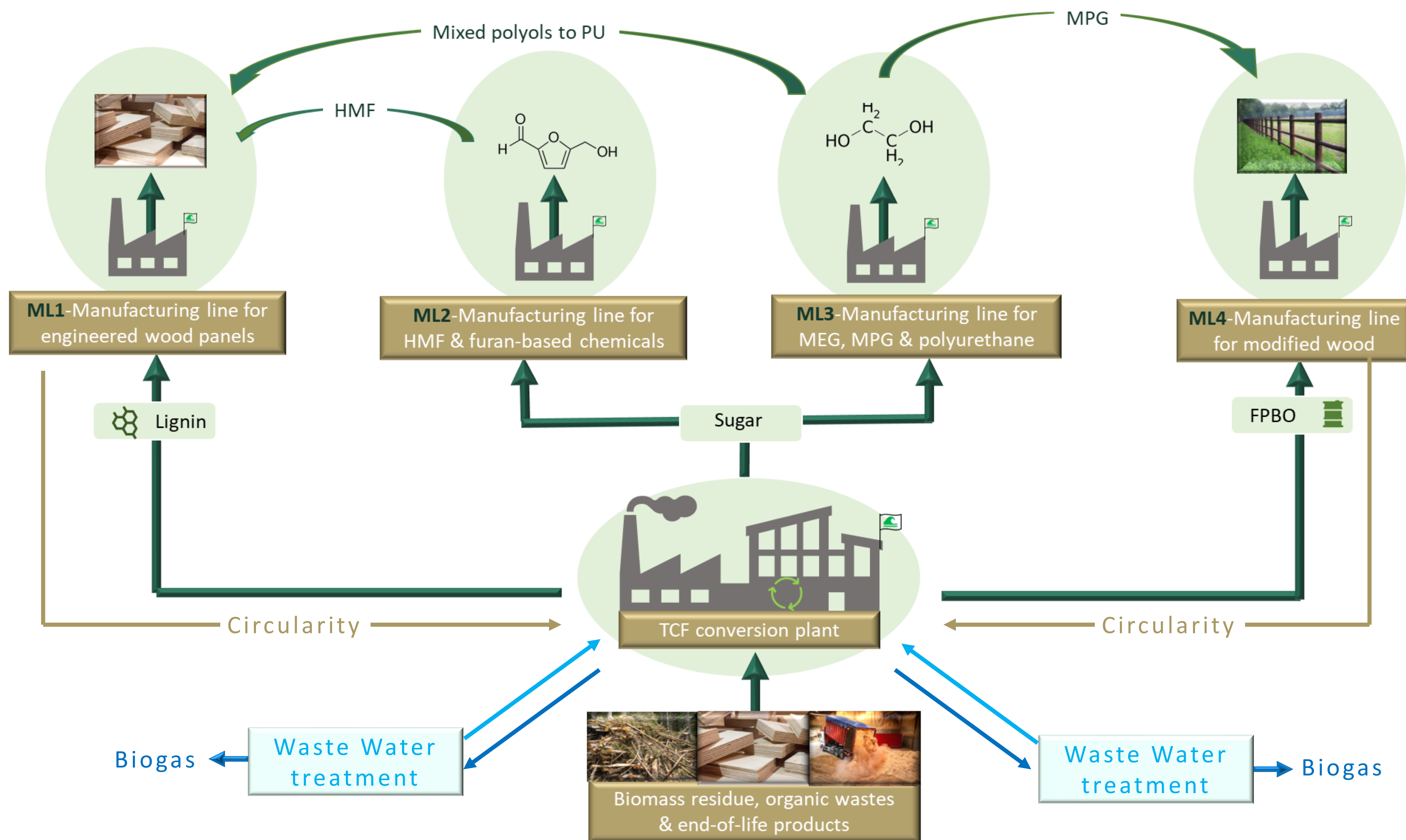
Status FPBO Fractionation:

- ✎ Fractionation proven by BTG on pilot-scale (120 kg/h FPBO feed)
- ✎ Technology License with BTG Bioliquids on implementing technology;
- ✎ Design of 1 t/h feed completed $\equiv$ 1,000 - 1,500 t solid pyrolytic lignin/year;
- ✎ 1° Demonstration plant foreseen for 2026-2027 by Aurora Renewable Chemicals.



Webinar: <https://www.newwave-horizon.eu/news/fast-pyrolysis-unlocking-new-opportunities-for-biobased-materials/> (see NewWave site)

NewWave approach



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FORESA
TECHNOLOGIES

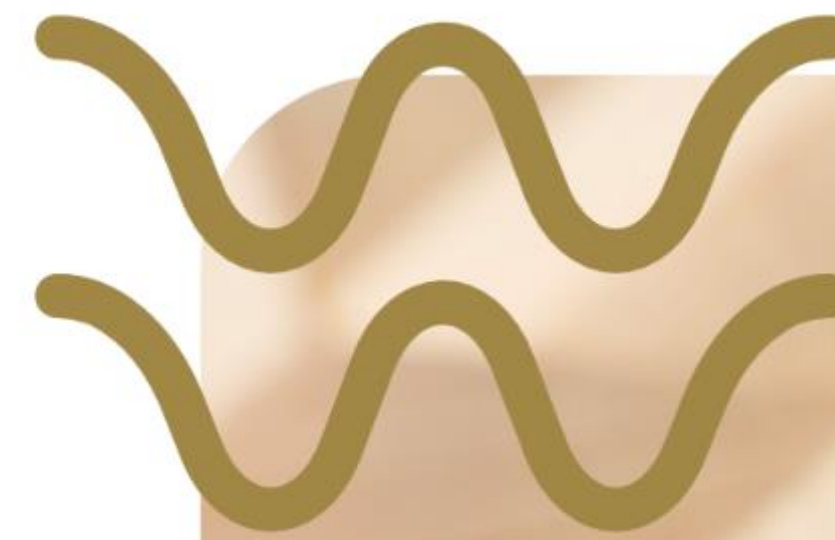
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04th March 2026



This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No. 101058369.



Our history



FORESA SPAIN



MARITIME TERMINAL



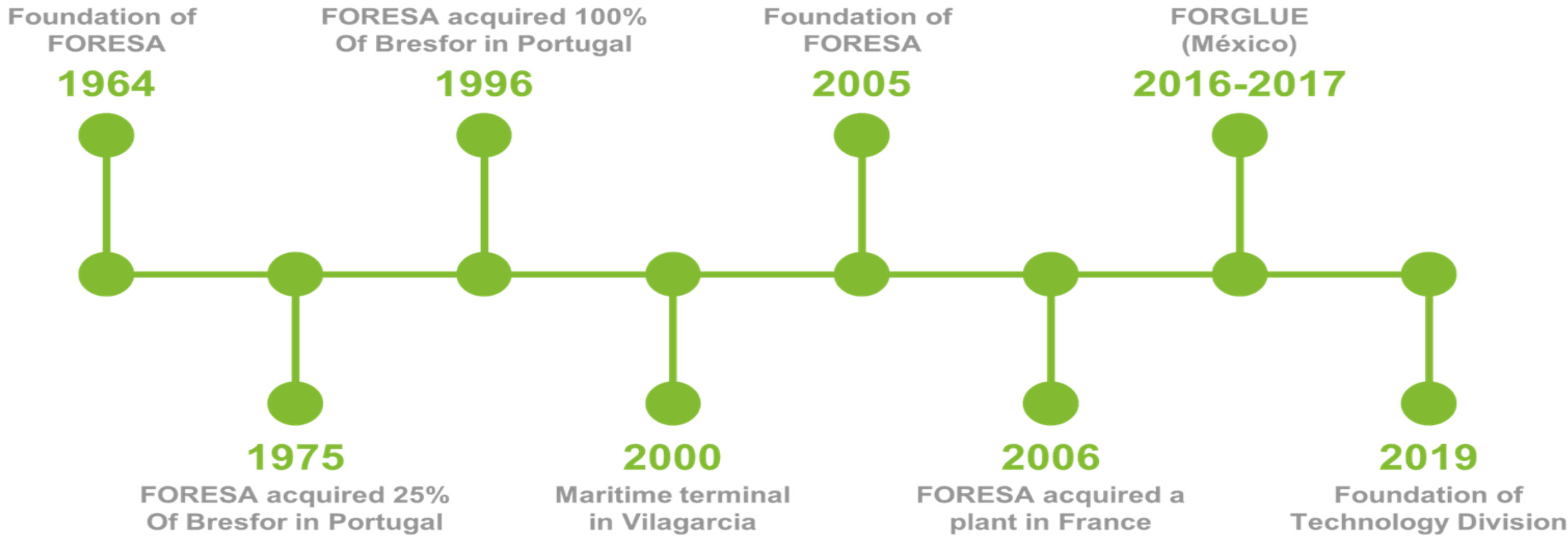
TECHNOLOGY DIVISION



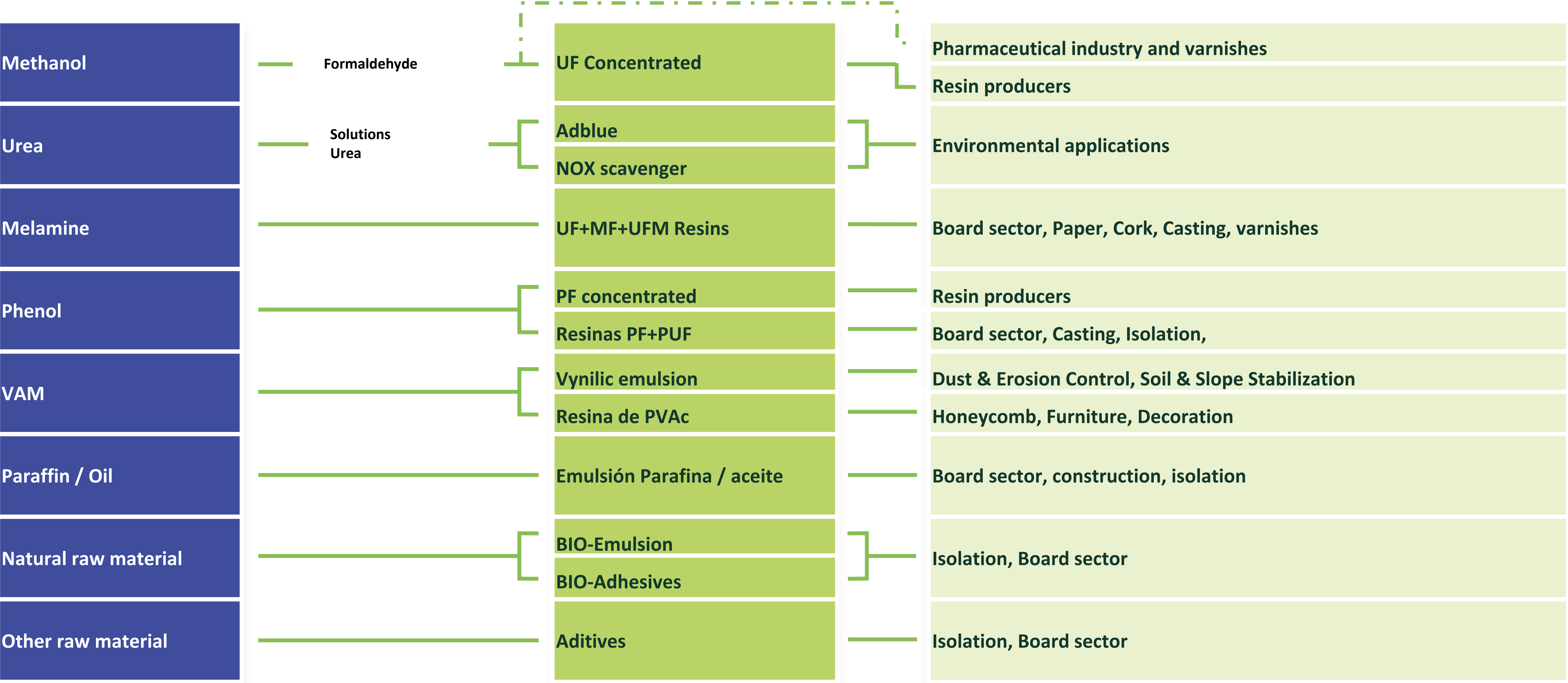
BRESFOR PORTUGAL



FORESA FRANCE



Our background



Naturally originated solutions

Objetive: Obtain products in a sustainable way, replacing raw materials of fossil origin with other renewable natural resources and different sources of Waste Materials.

From waste from the Agroforestry Sector

LIGNATURE

Resin based on biomas

PINATURE

Vegetable origen resin

FORSOY

Resin based on Protein

BIOWAX

Water-repellent emulsion based on vegetable fats

From Vegetables, Proteins, Fats and Sugars

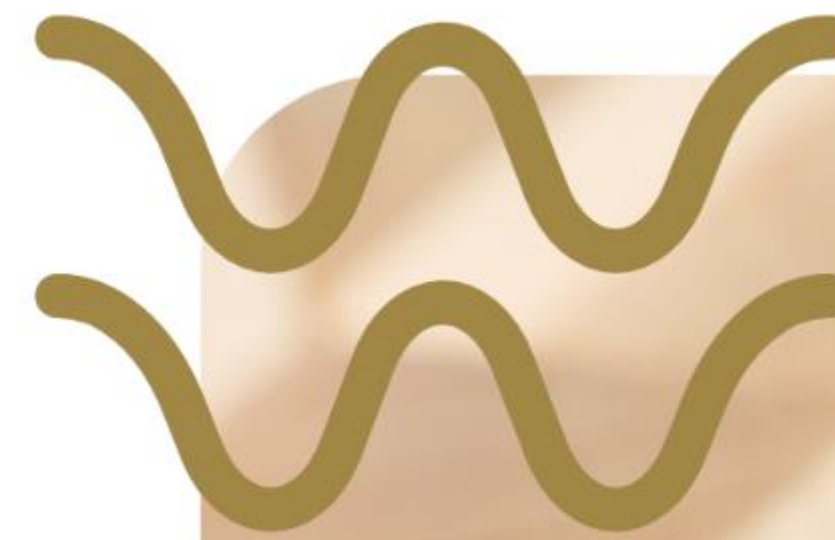


FORESA
TECHNOLOGIES

Manufacturing for engineered Wood panels



This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No. 101058369.





- | WP5 | YEAR 1 | | | | YEAR 2 | | | | YEAR 3 | | | | YEAR 4 | | | |
|----------|--------|---|---|---|--------|---|---|---|--------|---|---|---|--------|---|---|---|
| | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 |
| Task 5.1 | | | | | | | | | | | | | | | | |
| Task 5.2 | | | | | | | | | | | | | | | | |
| Task 5.3 | | | | | | | | | | | | | | | | |
| Task 5.4 | | | | | | | | | | | | | | | | |
| Task 5.5 | | | | | | | | | | | | | | | | |
| Task 5.6 | | | | | | | | | | | | | | | | |
| Task 5.7 | | | | | | | | | | | | | | | | |
- D5.1 (FSA, M12): Development of new plywood resins**

D5.2 (FSA, M24): Development of new plywood resins

D5.3 (FSA, M24): Sample manufactured with green resin

D5.5 (FSA, M24): LCA/LCC data

D5.6 (FSA, M36): LCA/LCC data

D5.7 (RuG,M27): Conversion MP's to phenol &cresol

D5.7 (RuG,M42): Conversion MP's to phenol &cresol

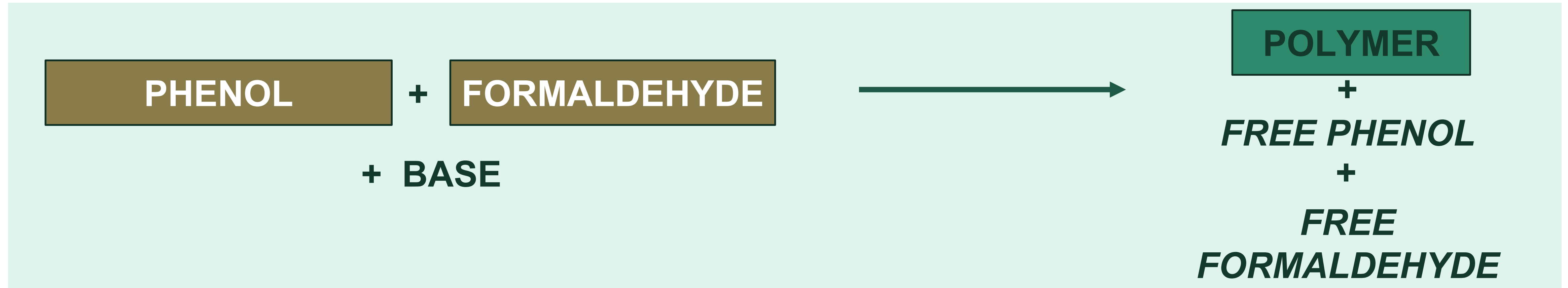
D5.4 (FSA, M45): Final report new green resins

MS5 (FSA, M45): 100%Biobased resin produced

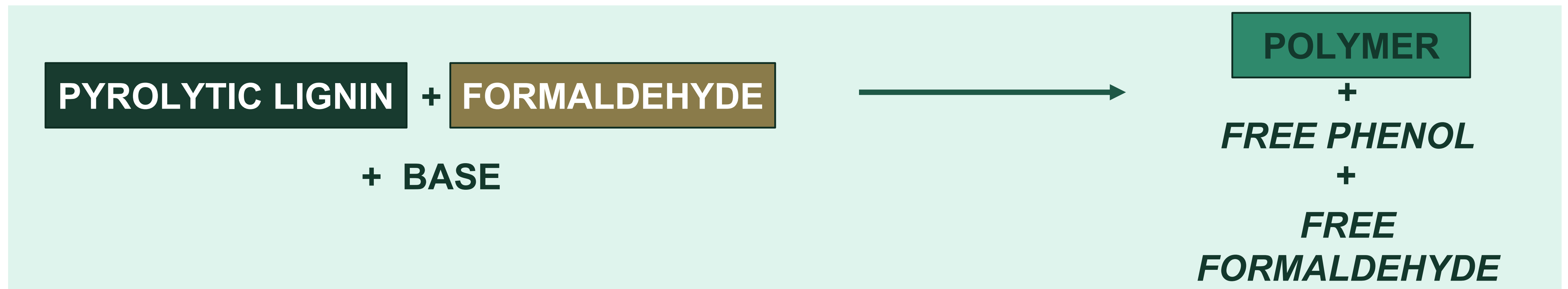
WP5 path way



- Standard Resin



- Phenol replacement



WP5: Manufacturing line for engineered wood panels

Pilot plant production of selected material



PLYWOOD PANNELS

- **Lignin used:** BTG NW SPL3
- **Replaced:** 50%

CONDITIONS

- **TEMPERATURE:** 120°C
- **DOSAGE:** 250 g/m²
- **CURE FACTOR:** 2 min/mm

Values of reference: EN 314

Average fv resistance (N/mm2)	Average breakage rate
$0,2 \leq f_v \leq 0,4$	≥ 80
$0,4 \leq f_v \leq 0,6$	≥ 60
$0,6 \leq f_v \leq 1,0$	≥ 40
$1,0 \leq f_v$	Not expecifications

Particle board	2 min/mm	
	Line 1	Line2
CLASS 1 Treatment		
$\bar{x}$ (PLYWOOD)	1,26	1,31
CLASS 2 Treatment		
$\bar{x}$ (PLYWOOD)	1,01	1,12

For InnoRenew

- Foresa Tech produced 16 plywood panels (50cm x 50 cm each).
- The panels were shipped to InnoRenew for testing during demo activities **Sub-task 3.5 and 8.4**



WP5: Manufacturing line for engineered wood panels



Pilot plant production of selected material

MDF PANNELS
▪ Lignin used: BTG NW SPL3 ▪ Replaced: 25%.

CONDITIONS
▪ TEMPERATURE: 220°C ▪ PERCENTAGE OF RESIN USED: 18% ▪ CURE FACTOR: 22 s/mm



Values of reference: EN 319

Property	Thickness ranges
	>12 at 19
Dry environment	
Swelling in thinckness 24h	12%
Internal Bond	0.55N/mm2
Wet environment: After Boil test	
Swelling in thinckness 24h	8 %
Internal Bond	0.12 N/mm2

Particle board	Density (Kg/m3)	IB (N/mm2)	Swelling 24 h (%)
Dry environment			
$\bar{x}$ (MDF)	704	0,56	3,83
Wet environment: After Boil test			
$\bar{x}$ (MDF)	756	0,31	7,12



For InnoRenew

- Foresa Tech produced 16 MDF panels (50cm x 50 cm each).
- The panels were shipped to InnoRenew for testing during demo activities **Sub-task 3.5 and 8.4**

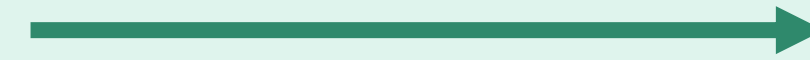
WP5 path way



- Phenol and Formaldehyde replacement

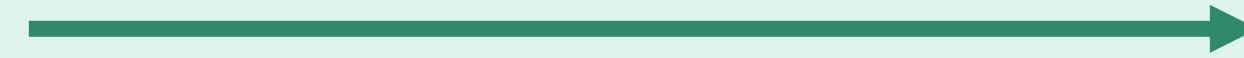
GREEN RESIN

PYROLYTIC LIGNIN + HMF + BASE



POLYMER

CRESOL + HMF + BASE



POLYMER

WP5: Manufacturing line for engineered wood panels



Development of a fully **GREEN RESIN**

Phenol Replacement

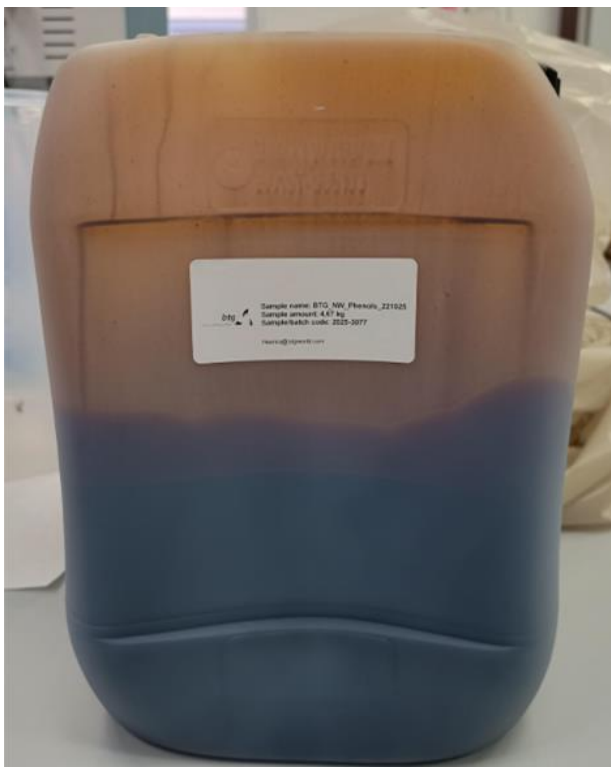
Pyrolytic Lignin: SPL1; SPL2; MP; LP

- Provided by BTG
- Starting with 4 different lignin
- Development of SPL3 Lignin: A new lignin, designated as SPL3, was developed as a combination of SPL1 and SPL2 lignins
- Optimal Performance: SPL3 lignin was selected for the final phases of the project → the best performance and results across the various resin formulations



Blended phenol (CRESOL)

- Provided by BTG



Sample	C %	H %	Ni %	FP, %
CRESOL	72,8%	8,27%	-	5,08

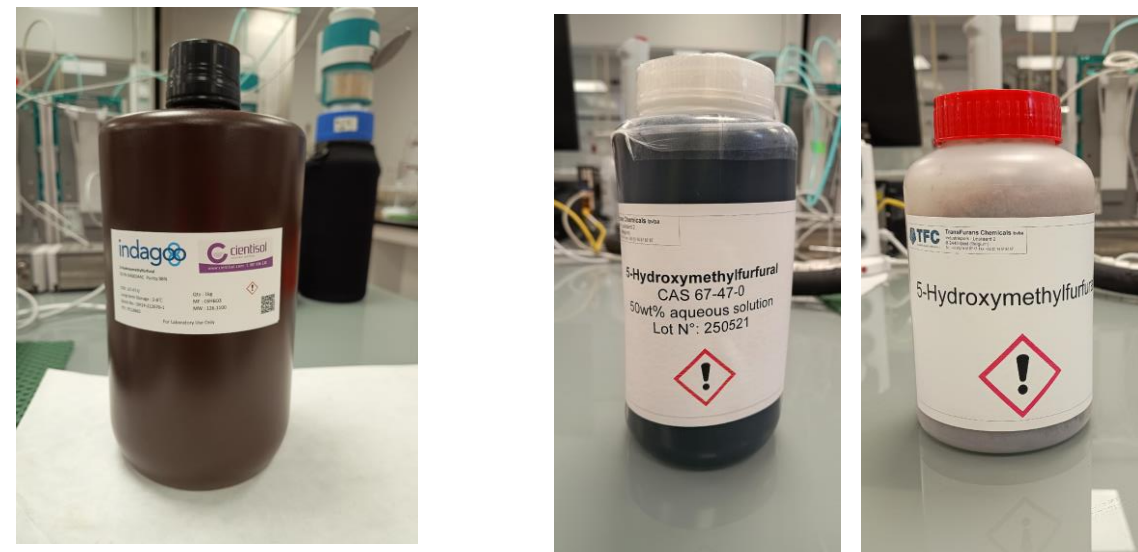
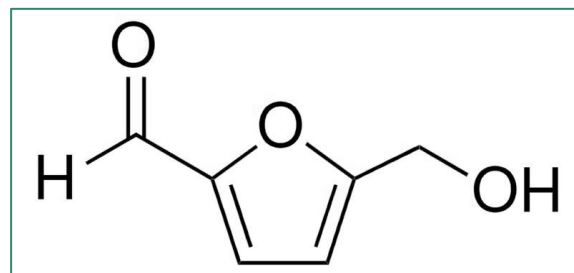
WP5: Manufacturing line for engineered wood panels



Development of a fully **GREEN RESIN**

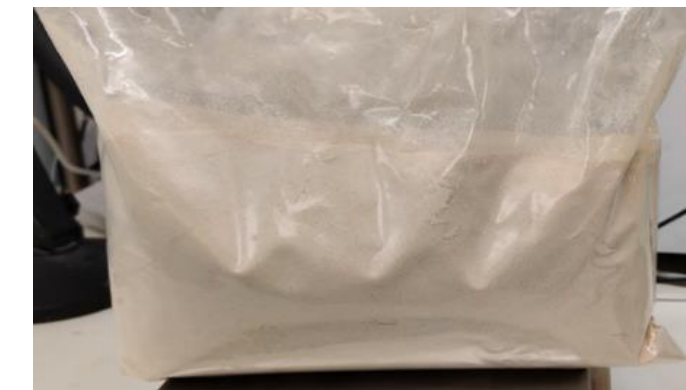
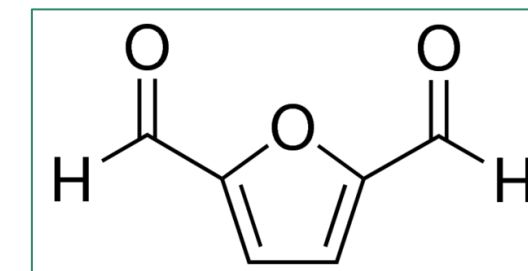
Formaldehyde Replacement

Hydroxymethylfurfural (HMF)



- Started with HMF commercial
- HMF Provided by TransFuranChemicals
- Renewable source
- Lower toxicity

2,5 Difurylfurfural (DFF)



- Provided by BTG
- Alternative to HMF
 - To try to reduce the drastic conditions to produce HMF resins
- **Not initially contemplated in the project scope**
- Solid raw material → Low solubility

WP5: Manufacturing line for engineered wood panels

Development of a fully sustainable **Green Resin**



Phenol = Cresol; Formaldehyde = HMF

RESULTS	HMF Substituted	Lignin Substituted	η , cP (25°C)	ρ , g/cm ³ (25°C)	pH (25°C)	H t, min	SC, %	FF, %	FP, %
$\bar{x}$ (E0)	0%	0%	267	1.198	10.5	19	49.8	0.05	2.09
$\bar{x}$ (MDF-HMF-Cresol)	100%	100%	415	1.204	11.4	>130	66,8	-	1,38

RESIN PRODUCTION

Processes

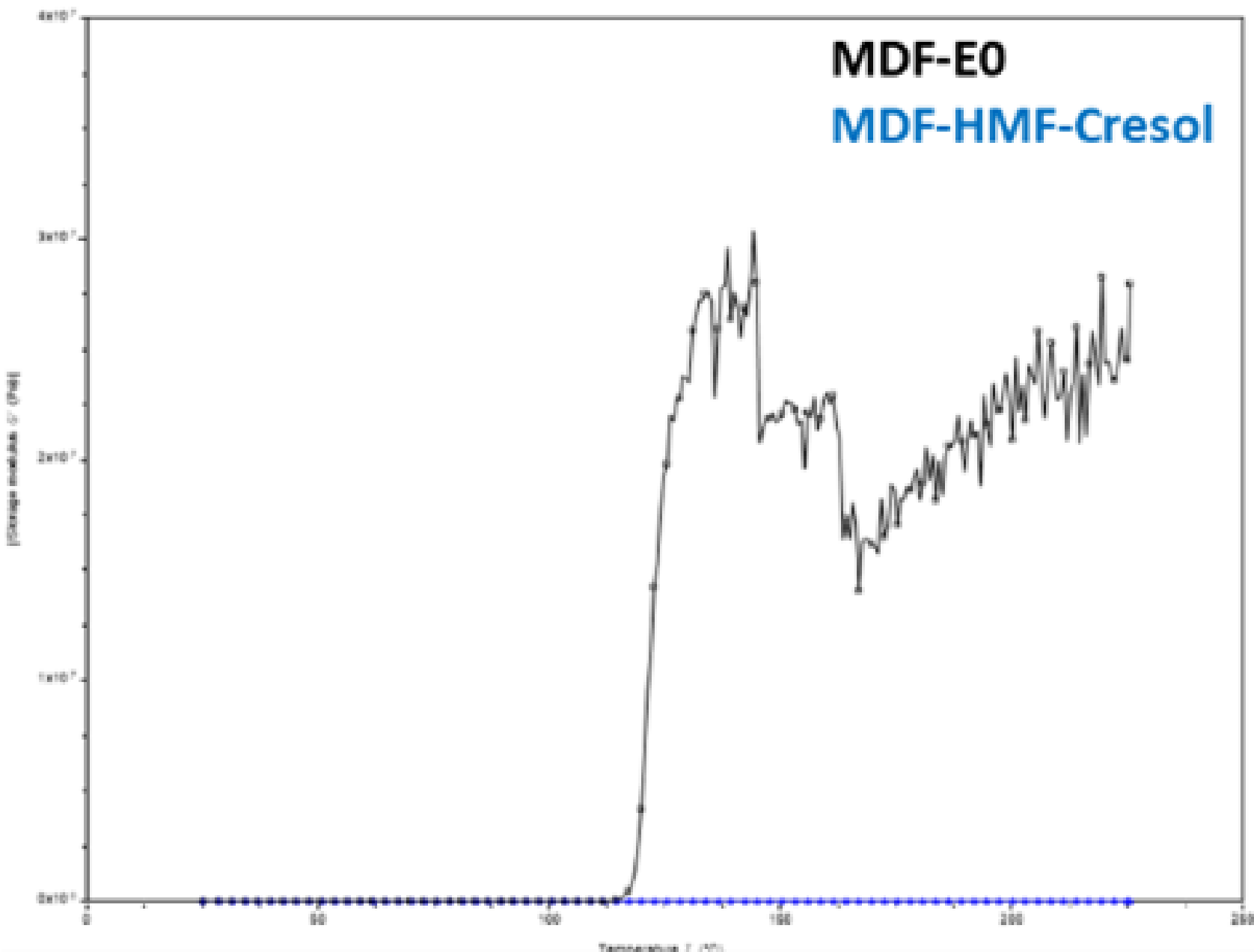
Recipe modification

- Increase the pH respect to standard recipe
- Temperature as standard process
- Processing time as standard process

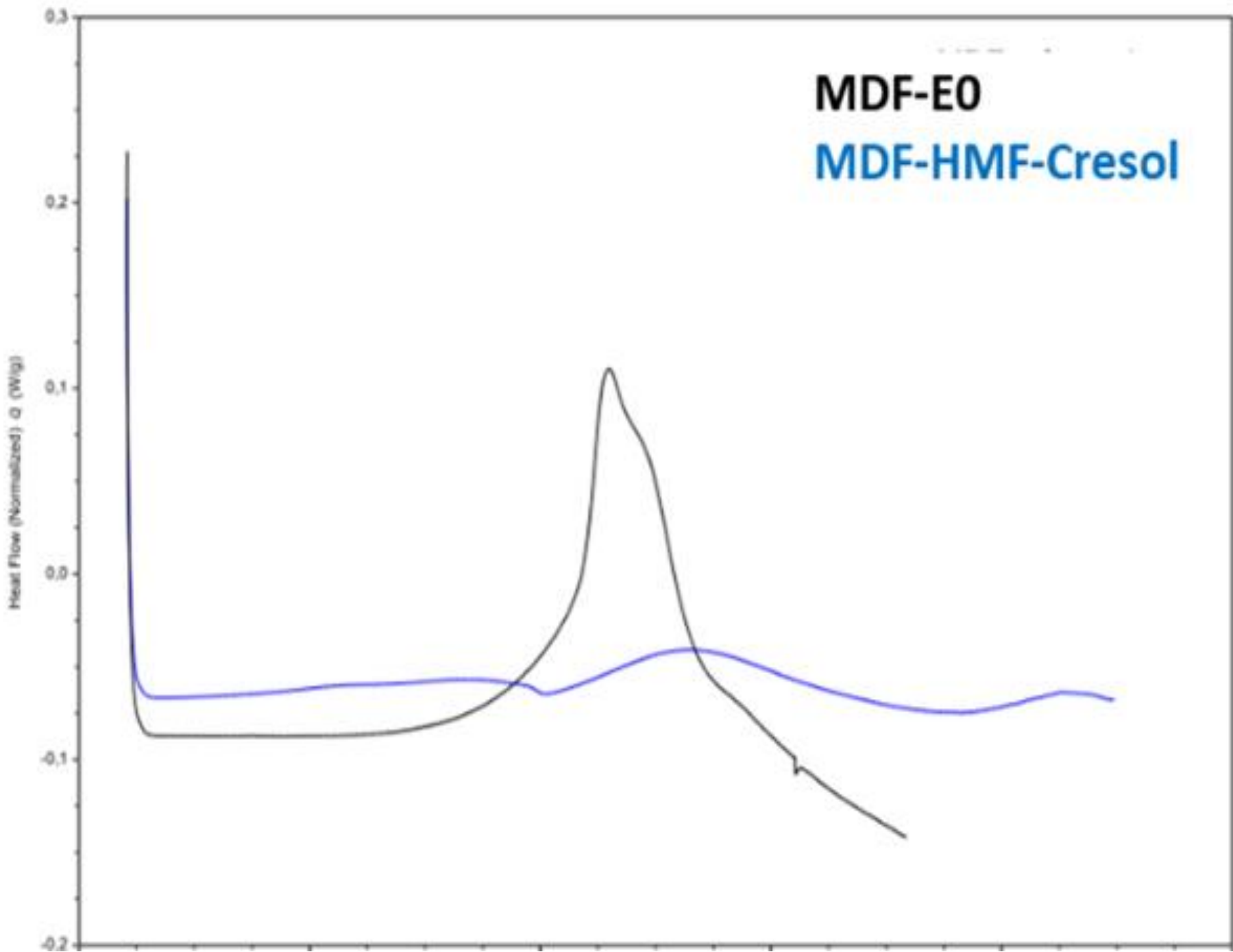
Final resin

- Viscosity achieve with standards
- Very low reactivity → rheological analysis demonstrated that the resin does not cure, which makes it unsuitable for panel production.

RHEOMETER



DSC



GPC

RESULTS	Mn (Da)	Mw (Da)	MP (Da)
$\bar{x}$ (MDF-E0)	5055	591082	349495
Cresol sample	40	119	146
$\bar{x}$ (MDF-HMF-Cresol)	47	151	143

WP5: Manufacturing line for engineered wood panels

Development of a fully sustainable **Green Resin**



Phenol = Pyrolytic Lignin (SPL3); Formaldehyde = HMF

RESULTS	HMF Substituted	Lignin Substituted	η , cP (25°C)	ρ , g/cm3 (25°C)	pH (25°C)	H t, min	SC, %	FF, %	FP, %
$\bar{x}$ (E0)	0%	0%	267	1,198	10,55	19	49,8	0.05	2.09
$\bar{x}$ (MDF-HMF-EE4)	100%	100%	381	1,203	11,04	138	52	-	-

RESIN PRODUCTION

Processes

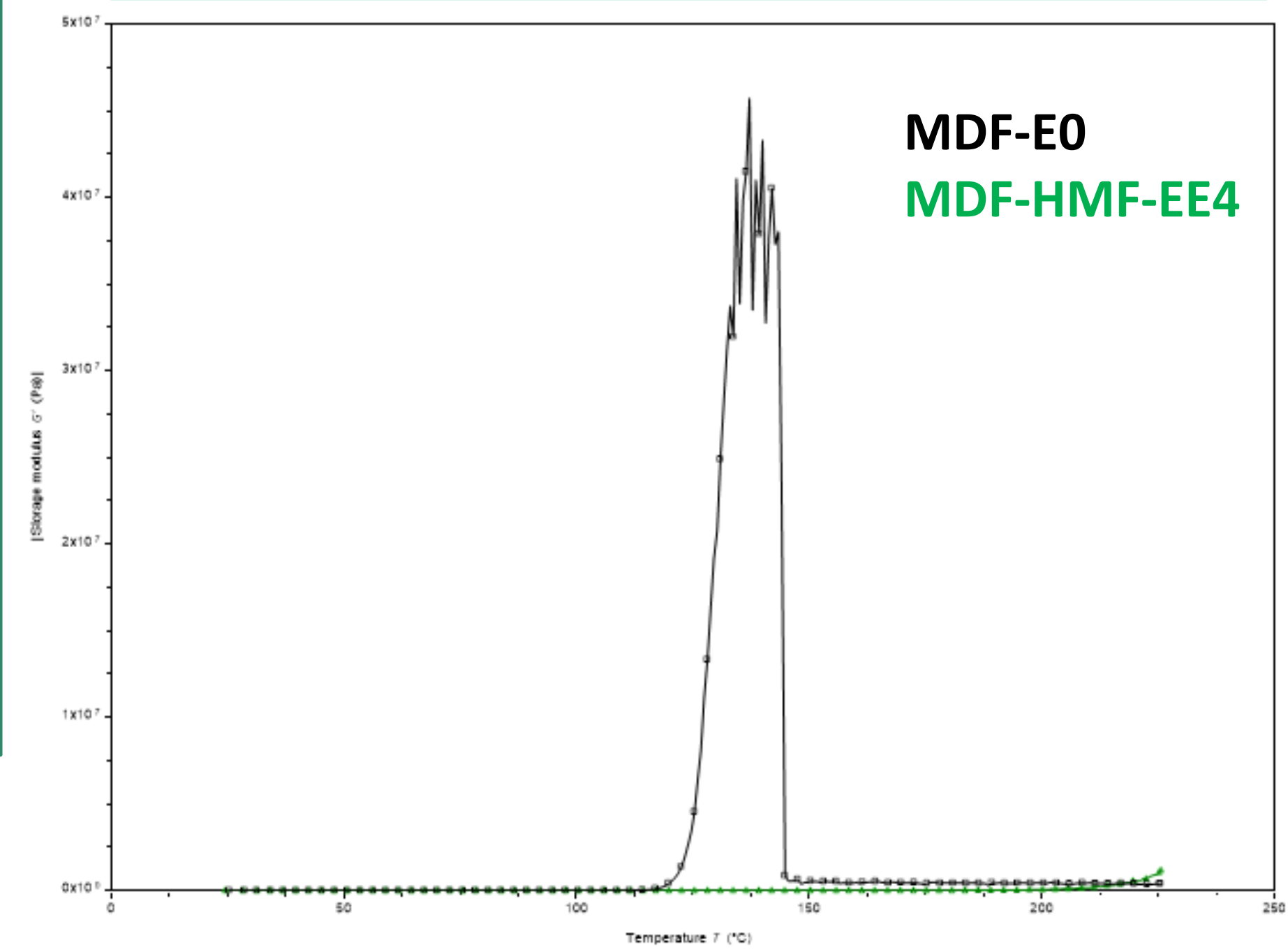
Recipe modification

- Increase temperature
 - Up to 95°C
- Long-lasting manufacturing process
 - Polymerization time 6h

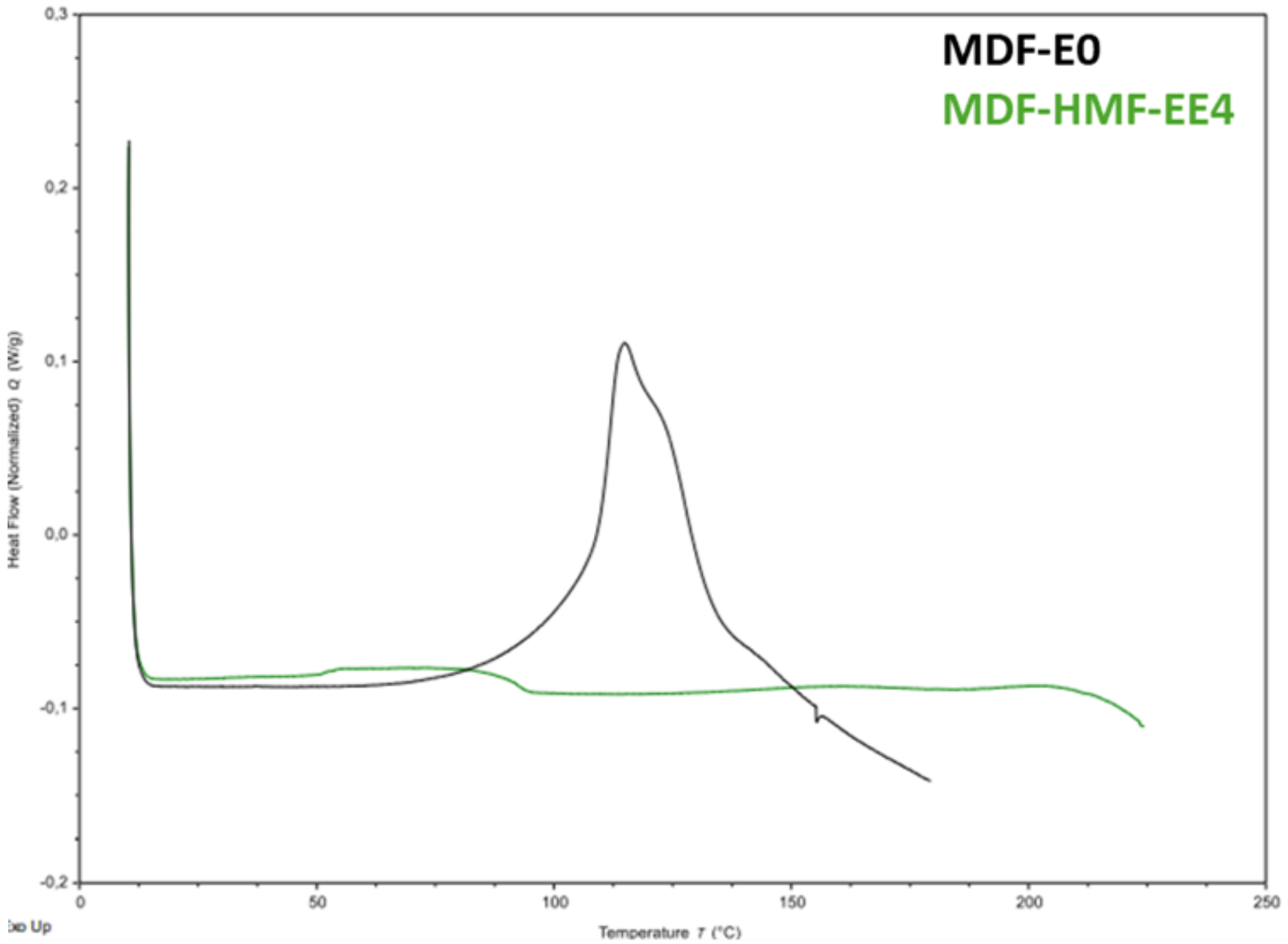
Final resin

- Viscosity achieve with standards
- Lower reactivity

RHEOMETER



DSC



GPC

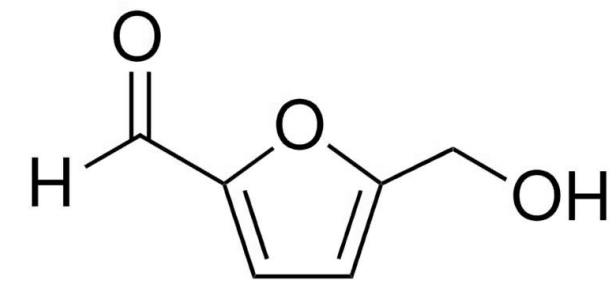
RESULTS	Mn (Da)	Mw (Da)	MP (Da)
$\bar{x}$ (MDF-E0)	5055	591082	349495
$\bar{x}$ (MDF-HMF-EE4)	3840	178560	186363

WP5: Manufacturing line for engineered wood panels

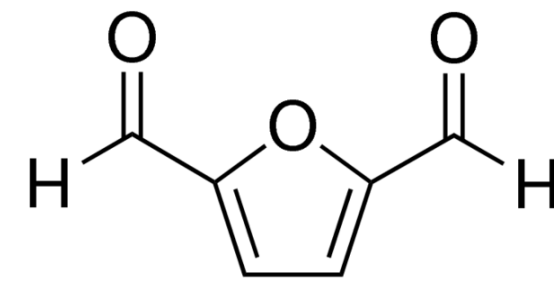


Development of a fully sustainable **Green Resin**

Phenol = Pyrolytic Lignin (SPL3); Formaldehyde = DFF



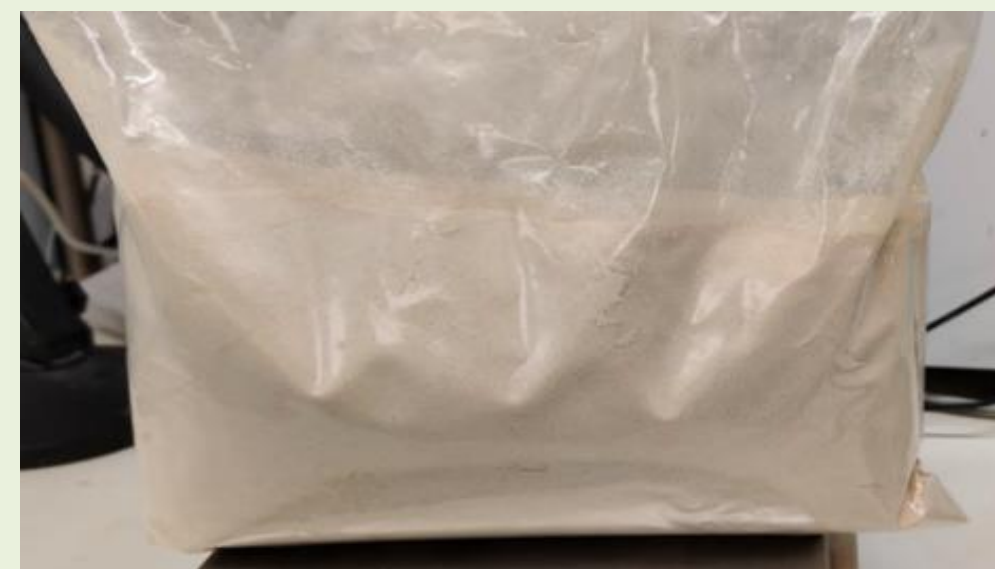
Hydroxymethylfurfural (HMF)



2,5 Difurylfurfural (DFF)

FORMALDEHYDE ALTERNATIVE

- 2,5 Difurylfurfural (DFF)
- Provided by BTG
- Alternative to HMF



- To try to reduce the drastic conditions for the production of HMF resins.
- Not initially contemplated in the project scope
- Solid raw material → Low solubility

RESIN PRODUCTION

Process

- Excessively high T^a for standard resin manufacturing processes (99°C)
- Monitoring viscosity
 - Precipitation generation observed
- The process is not continued

Final resin

- The final resin is not obtained
- DFF-based resin optimization was not elaborated → New projects



WP5: Manufacturing line for engineered wood panels

Development of a fully sustainable **PARTICLEBOARD** product



FORECO

CHIPS RADIATA



CHIPS MAPLE



PARTICLEBOARDS PANNELS

- **Green resin used**
- **Formaldehyde replaced:** 100% HMF
- **Phenol replaced:** 100% Lignin BTG NW SPL3

CONDITIONS

- **TEMPERATURE:** 220°C
- **PERCENTAGE OF RESIN USED:** 20%
- **CURE FACTOR:** 25 s/mm

- **Raw Material Issues:** Morphology and low density → Difficult to achieve a stable board structure.
- **Coating Deficiencies:** The standard resin content was insufficient to fully coat the wood particles, leading to poor uniform distribution→ Broken particleboard.
- **Low Reactivity:** The bio-based resin exhibited an excessively long hardening time (138 minutes).



Results of Internal bond and Swelling



Values of reference: EN 312

Particleboard	Internal bond (EN 319)	Swelling24h (EN 317)
P2-Standard furniture	≥0,35 N/mm ²	15-20%
P3-Non structural humid	≥0,45 N/mm ²	≤14 %
P4-Structural dry	≥0,45 N/mm ²	≤15 %
P5-Structural humid	≥0,45 N/mm ²	≤10 %
P6-Heave duty structural	≥0,50 N/mm ²	≤15 %

Particle board	Density (Kg/m3)	IB (N/mm2)	Swelling 24 h (%)
̄ (Particleboard- EE4)	468	0,21	31

WP5: Manufacturing line for engineered wood panels



CONCLUSION

Pannels elaboration with resin: Phenol replacement

- **PLY panels**
 - Resin used: **50% Lignin SPL3**; 100% Formaldehyde
 - Resin whit higher free formaldehyde content: **0,53%**
 - Plywood panel successfully meets Class 1 and Class 2 standards
- **MDF panels**
 - Resin used: **25% Lignin SPL3**; 100% Formaldehyde
 - Resin whit higher free formaldehyde content: **1,3%**
 - MDF panel successfully meets with standards

Green Resin development

- **Phenol= Cresol; Formaldehyde = HMF**
 - Standard Temperature
 - Standard time in elaboration process
 - No reactivity (resin does not cure)→ **unsuitable for panel production**
- **Phenol= Pyrolytic Lignin (SPL3); Formaldehyde = HMF**
 - Long time elaboration process
 - High temperature in polymerization process
 - Lower reactivity→ **unsuitable for industrial process**
- **Phenol= Pyrolytic Lignin (SPL3); Formaldehyde = DFF**
 - Alternative not contemplated in the project scope
 - Poor solubility
 - Excessively** high temperature
 - Precipitation formation**
 - Final resin not obtained**

↓
SELECTED GREEN RESIN

Development a fully sustainable product

- **Elaboration of Particleboard panels**
 - Raw Material Issues: Morphology and low density
 - Coating Deficiencies: The standard resin content was insufficient to fully coat the wood particles→ Broken particleboard
 - Particleboard does not reach the value of the standard**

Thank you!

 New Wave Project
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Modified wood products for outdoor applications

4 March, 2026

NewWave Public hybrid event & Show

Anna Sandak & Lex Kiezebrink

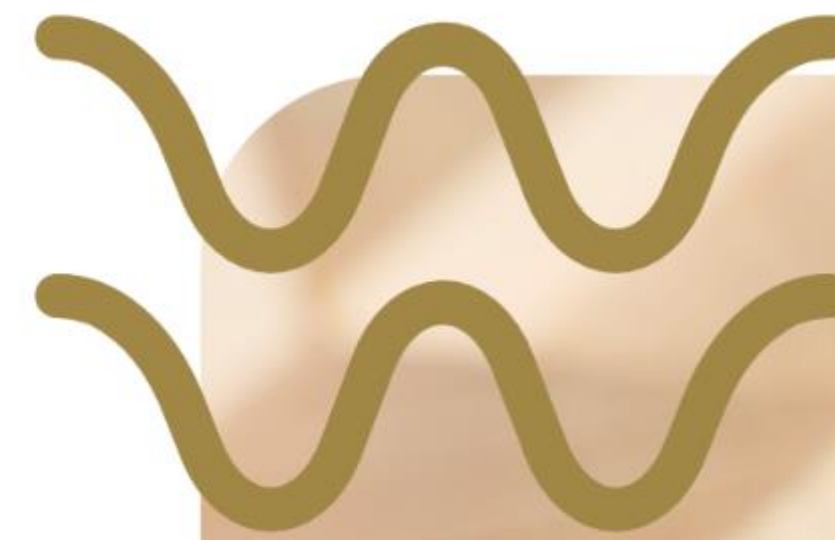


FORECO



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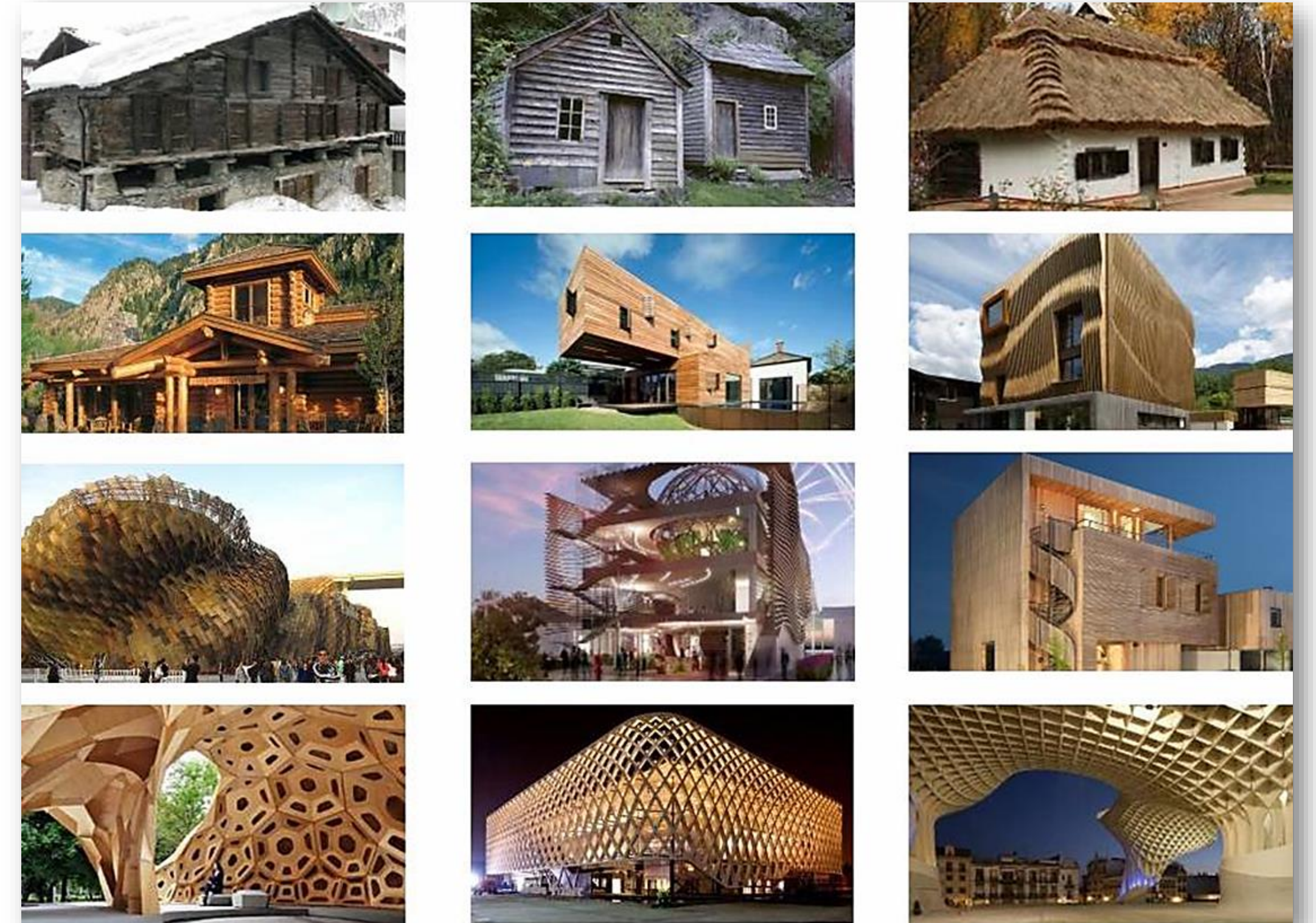




Why biomaterials?

*“The 18th century was about brick,
the 19th about steel,
the 20th about concrete,
and the 21st century is
about wood.”*

Alex de Rijke



Diversity of wood



There are over **60 000** different **wood species**, that might be used for several applications.

PERIODIC TABLE OF WOOD

27 lbs/ft³ • 425 kg/m³ SITKA SPRUCE	23 lbs/ft³ • 370 kg/m³ WESTERN RED CEDAR	32 lbs/ft³ • 510 kg/m³ DOUGLAS FIR													42 lbs/ft³ • 675 kg/m³ ENGLISH YEW	38 lbs/ft³ • 610 kg/m³ WYCH elm	33 lbs/ft³ • 540 kg/m³ LONDON PLANE	44 lbs/ft³ • 710 kg/m³ EUROPEAN BEECH	40 lbs/ft³ • 640 kg/m³ ENGLISH WALNUT	40 lbs/ft³ • 640 kg/m³ MASUE BIRCH
28 lbs/ft³ • 450 kg/m³ RED ALDER	30 lbs/ft³ • 485 kg/m³ BOX ELDER													61 lbs/ft³ • 975 kg/m³ BOXWOOD	62 lbs/ft³ • 990 kg/m³ OLIVE	32 lbs/ft³ • 520 kg/m³ CEDAR OF LEBANON	42 lbs/ft³ • 675 kg/m³ ENGLISH OAK	38 lbs/ft³ • 615 kg/m³ SYCAMORE MAPLE	42 lbs/ft³ • 680 kg/m³ EUROPEAN ASH	
26 lbs/ft³ • 415 kg/m³ REDWOOD	44 lbs/ft³ • 705 kg/m³ HARD MAPLE	35 lbs/ft³ • 560 kg/m³ BLACK CHERRY	26 lbs/ft³ • 415 kg/m³ BASSWOOD	28 lbs/ft³ • 405 kg/m³ RED elm	42 lbs/ft³ • 675 kg/m³ WHITE ASH	43 lbs/ft³ • 690 kg/m³ YELLOW BIRCH	44 lbs/ft³ • 700 kg/m³ RED OAK	31 lbs/ft³ • 495 kg/m³ SASSAFRAS	27 lbs/ft³ • 435 kg/m³ BUTTERNUT	30 lbs/ft³ • 480 kg/m³ AMERICAN CHESTNUT	47 lbs/ft³ • 745 kg/m³ PARAKU	45 lbs/ft³ • 730 kg/m³ AFRORMOSIA	34 lbs/ft³ • 540 kg/m³ AFRICAN WALNUT	41 lbs/ft³ • 655 kg/m³ TEAK	33 lbs/ft³ • 520 kg/m³ EAST INDIAN ROSEWOOD	42 lbs/ft³ • 675 kg/m³ BAMBOO	16 lbs/ft³ • 260 kg/m³ PAULOWNIA			
40 lbs/ft³ • 640 kg/m³ CLARO WALNUT	54 lbs/ft³ • 855 kg/m³ OSAGE ORANGE	48 lbs/ft³ • 775 kg/m³ BLACK LOCUST	50 lbs/ft³ • 800 kg/m³ SHAGBARK HICKORY	47 lbs/ft³ • 755 kg/m³ WHITE OAK	33 lbs/ft³ • 530 kg/m³ EASTERN RED CEDAR	34 lbs/ft³ • 545 kg/m³ SYCAMORE	38 lbs/ft³ • 610 kg/m³ BLACK WALNUT	29 lbs/ft³ • 455 kg/m³ YELLOW POPLAR	38 lbs/ft³ • 615 kg/m³ SOUTHERN YELLOW PINE	32 lbs/ft³ • 515 kg/m³ BALD CYPRESS	51 lbs/ft³ • 815 kg/m³ DI'ANGKOL	39 lbs/ft³ • 555 kg/m³ LIMBA	33 lbs/ft³ • 540 kg/m³ MANSONIA	41 lbs/ft³ • 675 kg/m³ BLACK PALM	37 lbs/ft³ • 595 kg/m³ SISSOO	51 lbs/ft³ • 815 kg/m³ RUBBERWOOD	58 lbs/ft³ • 925 kg/m³ BLACK AND WHITE REDWOOD			
72 lbs/ft³ • 1150 kg/m³ KATALOK	53 lbs/ft³ • 855 kg/m³ BOCOTE	48 lbs/ft³ • 1095 kg/m³ COCOBOL	41 lbs/ft³ • 655 kg/m³ HONDURAN MAHOGANY	40 lbs/ft³ • 640 kg/m³ REDHEART	50 lbs/ft³ • 805 kg/m³ ZIRICOTE	64 lbs/ft³ • 1025 kg/m³ HONDURAN ROSEWOOD	75 lbs/ft³ • 1200 kg/m³ KINGWOOD	62 lbs/ft³ • 990 kg/m³ CHECHEN	65 lbs/ft³ • 1035 kg/m³ CHAKTE VIGA	40 lbs/ft³ • 640 kg/m³ AFRICAN MAHOGANY	50 lbs/ft³ • 810 kg/m³ ZEBRA WOOD	54 lbs/ft³ • 870 kg/m³ WENGE	56 lbs/ft³ • 890 kg/m³ BUBINGA	72 lbs/ft³ • 1150 kg/m³ MACASSAR EBONY	41 lbs/ft³ • 655 kg/m³ NARRA	42 lbs/ft³ • 675 kg/m³ DARK RED MERANTI				
29 lbs/ft³ • 470 kg/m³ SPANISH CEDAR	37 lbs/ft³ • 510 kg/m³ JATOPA	56 lbs/ft³ • 905 kg/m³ PURPLEHEART	70 lbs/ft³ • 1280 kg/m³ LIGNUM VITAE	57 lbs/ft³ • 905 kg/m³ GONCALO ALVES	37 lbs/ft³ • 515 kg/m³ SANTOS MAHOGANY	34 lbs/ft³ • 545 kg/m³ LEOPARDWOOD	9 lbs/ft³ • 150 kg/m³ BALSA	29 lbs/ft³ • 465 kg/m³ PRIMAVERA	38 lbs/ft³ • 600 kg/m³ MONKEYPOD	60 lbs/ft³ • 955 kg/m³ GABON EBONY	43 lbs/ft³ • 660 kg/m³ MAKORE	45 lbs/ft³ • 720 kg/m³ MOVINGUI	50 lbs/ft³ • 805 kg/m³ AFZELIA	43 lbs/ft³ • 675 kg/m³ MANGO	51 lbs/ft³ • 815 kg/m³ MERBAU	38 lbs/ft³ • 610 kg/m³ KOA				
CENTRAL AMERICA			SOUTH AMERICA						AFRICA				ASIA / AUSTRALIA							
AVERAGE DRIED WEIGHT (AT 12% MOISTURE CONTENT)			WOOD SAMPLE			COMMON NAME			COMMON NAME			COMMON NAME			COMMON NAME					
59 lbs/ft³ • 935 kg/m³ MACACAURA	68 lbs/ft³ • 1085 kg/m³ CUMARU	37 lbs/ft³ • 600 kg/m³ PERUVIAN WALNUT	54 lbs/ft³ • 865 kg/m³ PAU FERRO	43 lbs/ft³ • 1005 kg/m³ MASLEWOOD	63 lbs/ft³ • 1010 kg/m³ GREENHEART	60 lbs/ft³ • 970 kg/m³ TULIPWOOD	52 lbs/ft³ • 835 kg/m³ BRAZILIAN ROSEWOOD	73 lbs/ft³ • 1170 kg/m³ SHAKWOOD	38 lbs/ft³ • 615 kg/m³ MUNINGA	41 lbs/ft³ • 660 kg/m³ IROKO	42 lbs/ft³ • 670 kg/m³ SAPELE	30 lbs/ft³ • 485 kg/m³ AUSTRALIAN RED CEDAR	36 lbs/ft³ • 575 kg/m³ SILKY OAK	41 lbs/ft³ • 650 kg/m³ AUSTRALIAN CYPRESS						
52 lbs/ft³ • 830 kg/m³ CANARYWOOD	52 lbs/ft³ • 825 kg/m³ BLACK MESQUITE	33 lbs/ft³ • 530 kg/m³ LACEWOOD	76 lbs/ft³ • 1190 kg/m³ VERAWOOD	64 lbs/ft³ • 1025 kg/m³ CEBIL	52 lbs/ft³ • 825 kg/m³ YELLOWHEART	69 lbs/ft³ • 1100 kg/m³ IFE	66 lbs/ft³ • 1050 kg/m³ BLOODWOOD	41 lbs/ft³ • 660 kg/m³ IMBUEA	34 lbs/ft³ • 550 kg/m³ ANIGRE	66 lbs/ft³ • 1065 kg/m³ PINK IVORY	79 lbs/ft³ • 1270 kg/m³ AFRICAN BLACKWOOD	52 lbs/ft³ • 835 kg/m³ JARRAH	34 lbs/ft³ • 540 kg/m³ KAURI	40 lbs/ft³ • 640 kg/m³ AUSTRALIAN BLACKWOOD						

A SPECIAL THANKS TO STEVE EARLE, JUSTIN HOLDEN, AND MIKE LEISHER FOR PROVIDING SOME OF THE WOOD SAMPLES USED IN THIS POSTER.
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Degradation processes during service life



type	weathering	decay	waterlogging	insects	vandalism	fire	flood	earthquake
causes								
Processes (chemical & physical)	oxidation hydrolysis erosion abrasion fracture	oxidation hydrolysis depolymeriza tion reduction	oxidation hydrolysis swelling shrinkage	depolymeriz ation chewing	abrasion cracking fracture	dehydration oxidation hydrolysis	swelling shrinkage freezing cracking	fracture cracking
affected properties	colour gloss roughness integrity	colour gloss density integrity mechanical properties	colour gloss density integrity mechanical properties	colour density integrity mechanical properties	colour integrity	colour density integrity mechanical properties	colour density integrity mechanical properties	integrity mechanical properties
aesthetic	✓	✓	✓	✓	✓	✓	✓	✓
function		✓	✓	✓		✓	✓	✓
safety		✓	✓	✓		✓		✓

Wood modification processes

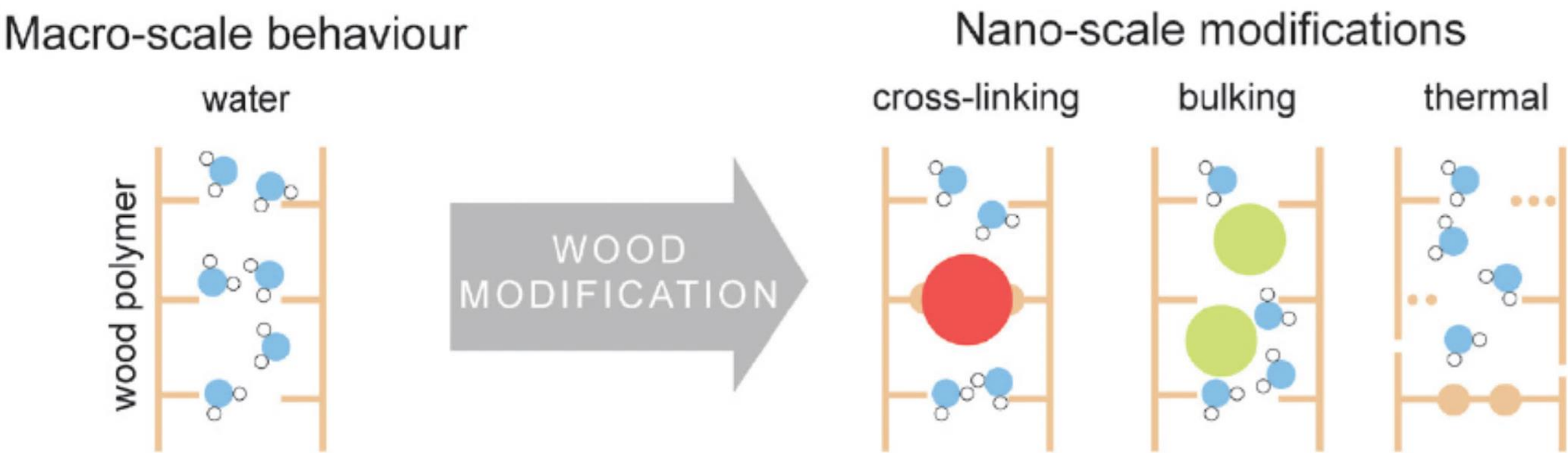


Active Modifications

- Result in a change to the chemical nature of the material

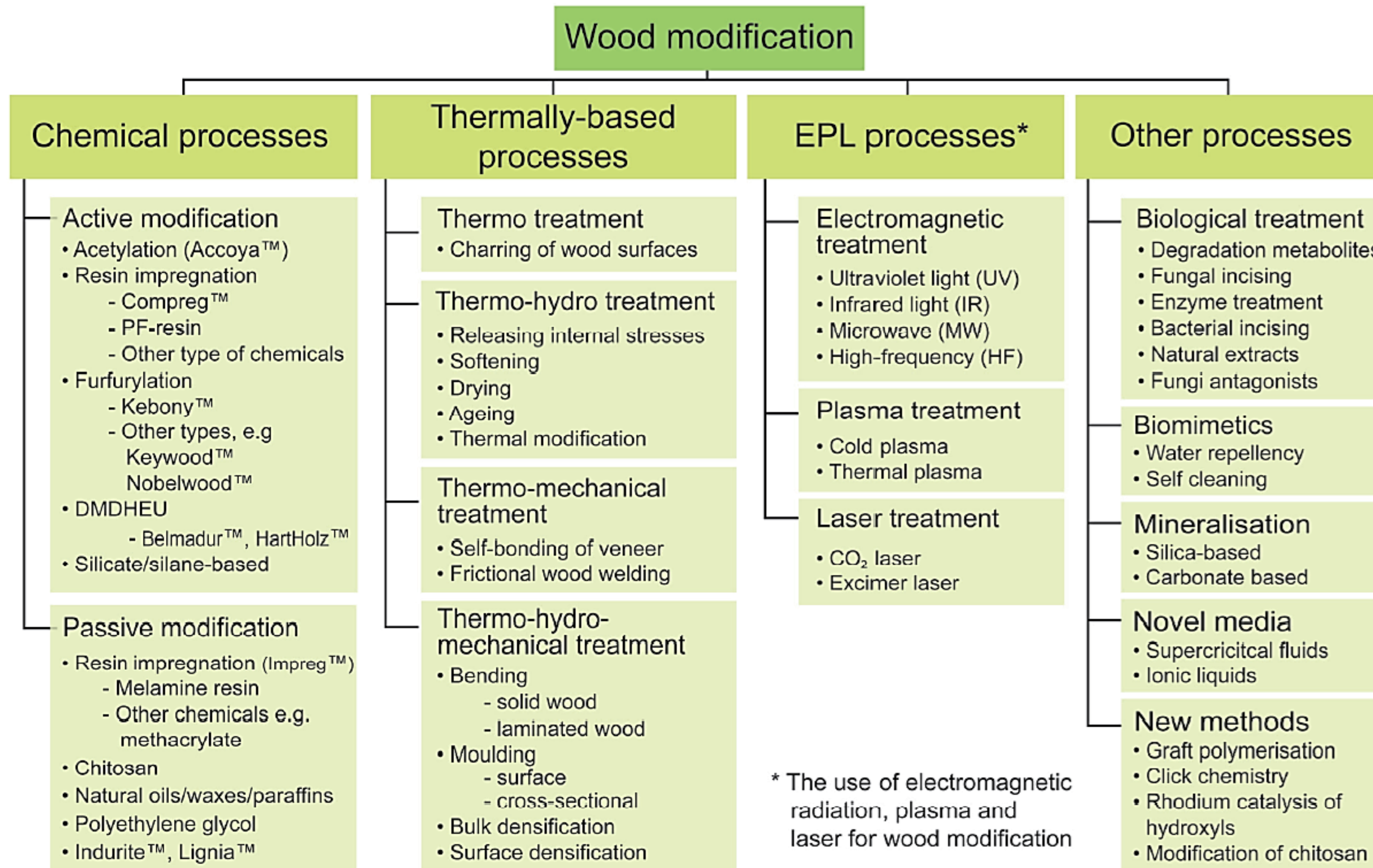
Passive Modifications

- Change the properties of the material, but without an alteration of the chemistry of the material



Passive modifications		Active modifications		
lumen filling	cell-wall filling	reaction with wood polymers	cross-linking	degradation of the cell wall

Wood modification processes

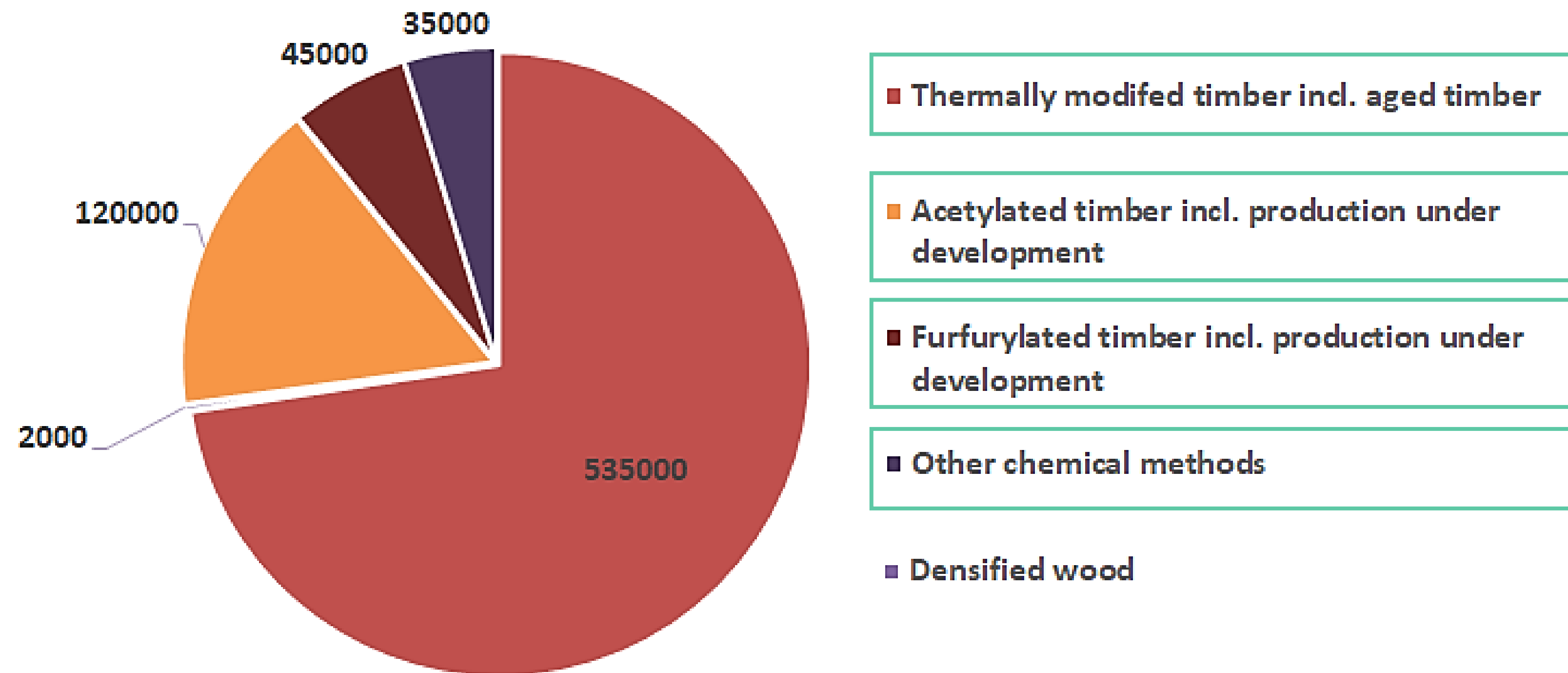


Overview of wood modification processes (modified from Jones et al., 2019).

Wood modification in Europe

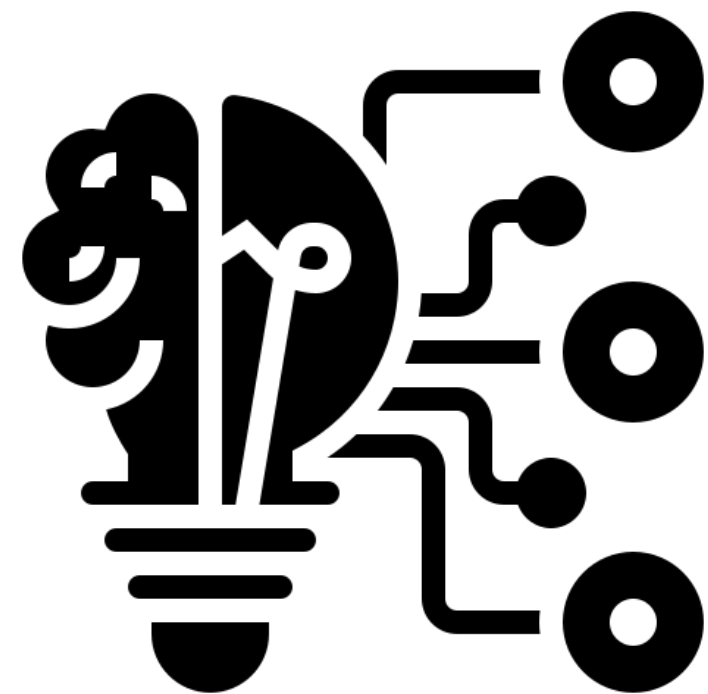


Europe currently holds nearly **70% share** in the **global wood modification market** value



Estimated annual production volumes for the nearest coming years
for some specific types of modified wood (in m³)

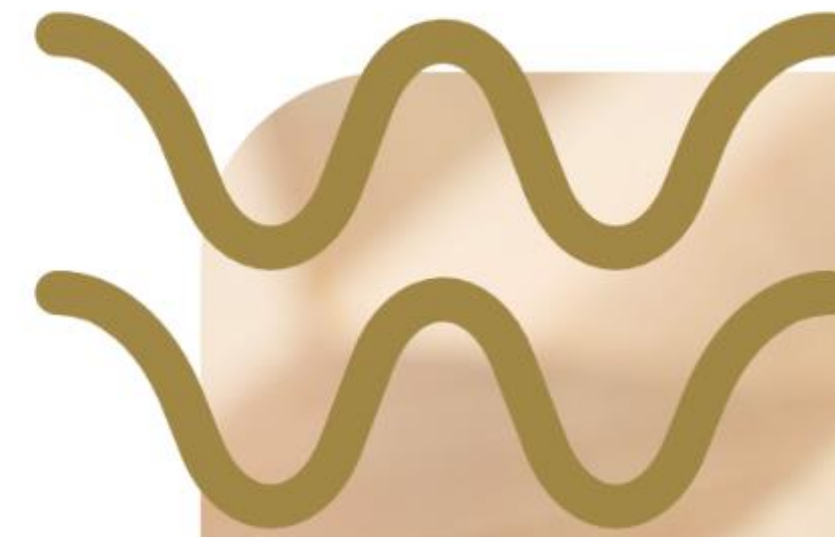
Current trends



- Quality control of established processes
- Treatment of alternative wood species
- Hybrid modifications
- Green processes (in terms of chemicals, energy savings)
- Alternative processes (biobased, enzymatic, biomimetic)
- New functionalities (phase changing materials, transparent wood, etc)



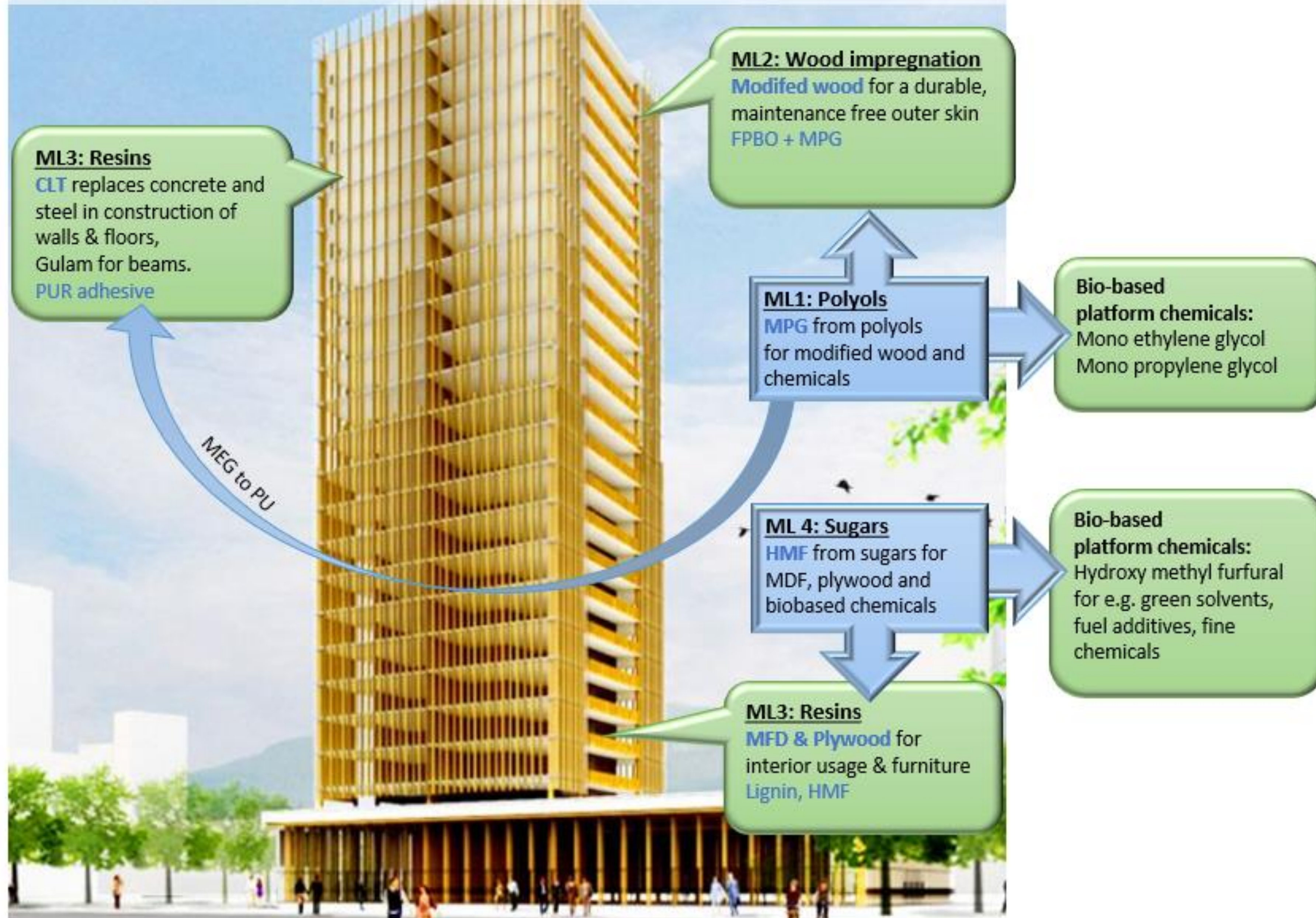
WP6: ML4 Manufacturing line for wood modification



Funded by
the European Union

Grant Agreement No. 101058369. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or HADEA. Neither the European Union nor the granting authority can be held responsible for them

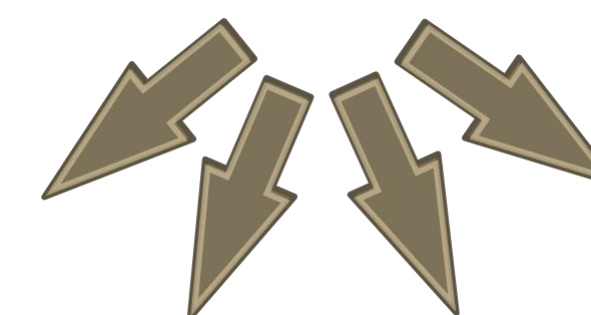
NewWave: building a circular economy



residual biomass &
end-of-life products



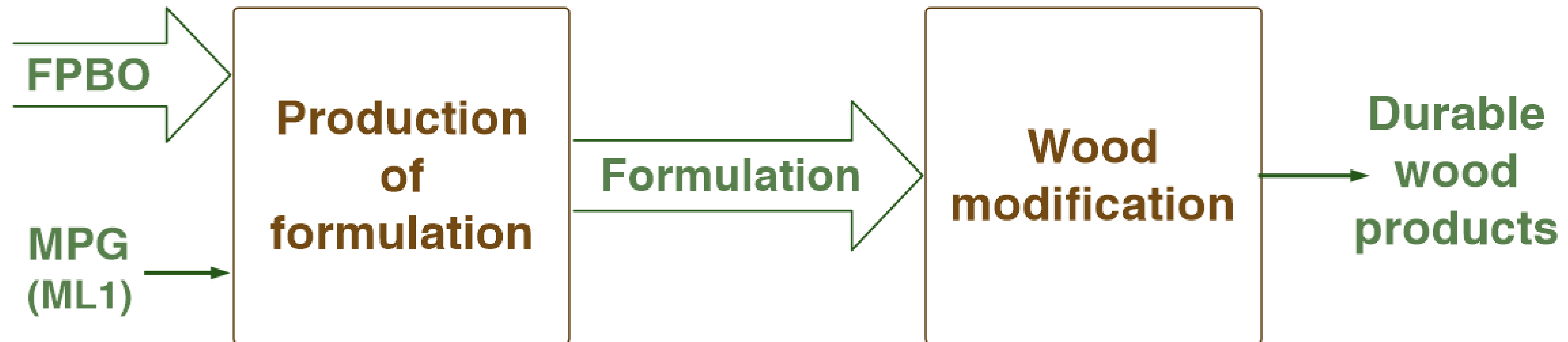
fast pyrolysis bio-oil
from thermo-chemical
fractionation



furan-based chemicals
polyols & polyurethanes
engineered wood products
modified wood



ML4 - Manufacturing line for modified wood



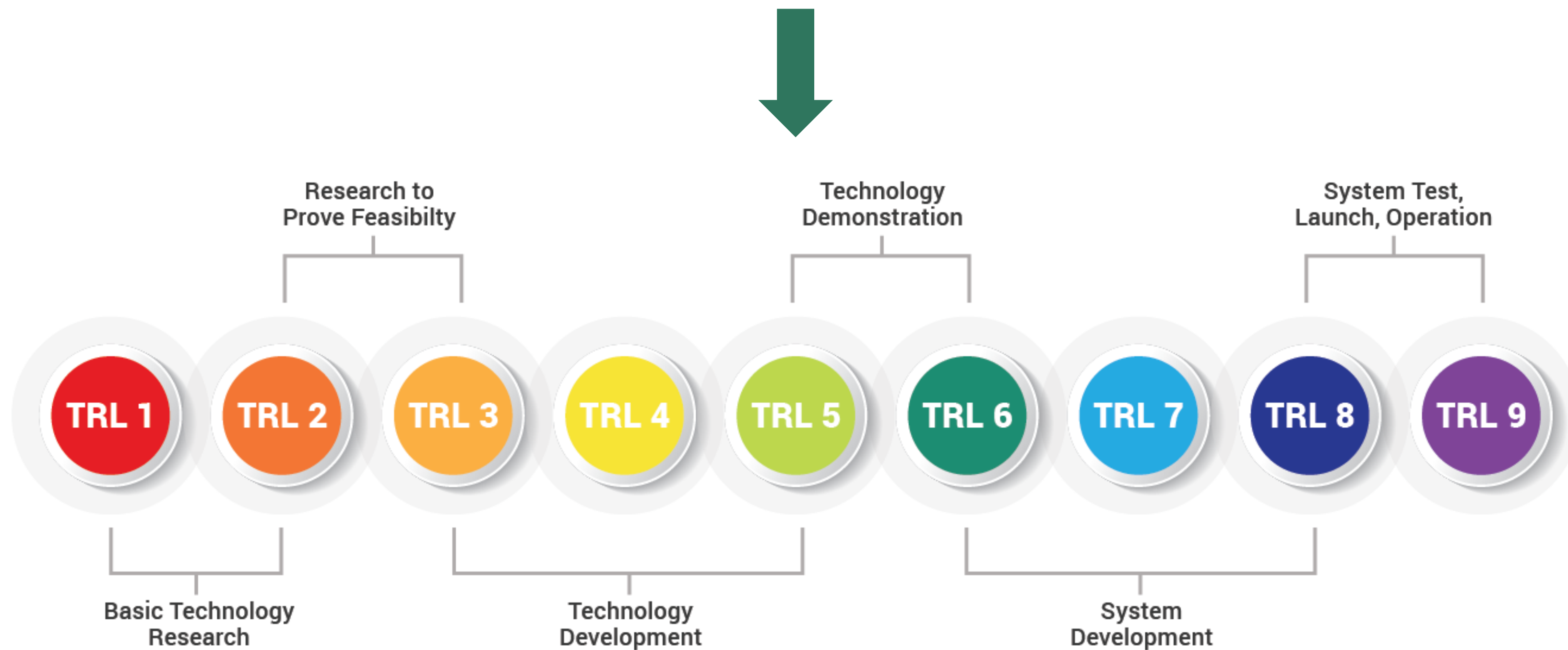
WP6 target



TRL 4-5 → TRL6

Technology **validated** in lab - Technology **validated** in relevant environment

Technology **demonstrated** in a relevant environment



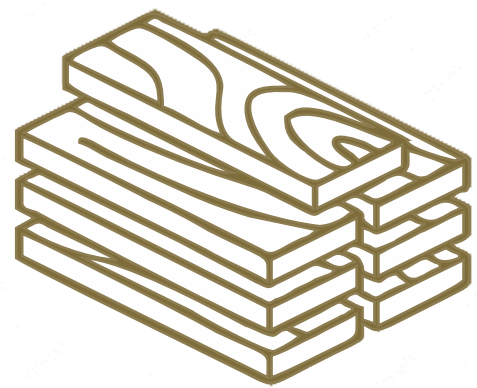
WP6 objectives



- To optimize formulations based on Fast Pyrolysis Bio-oil (FPBO) for use as a wood modification agent



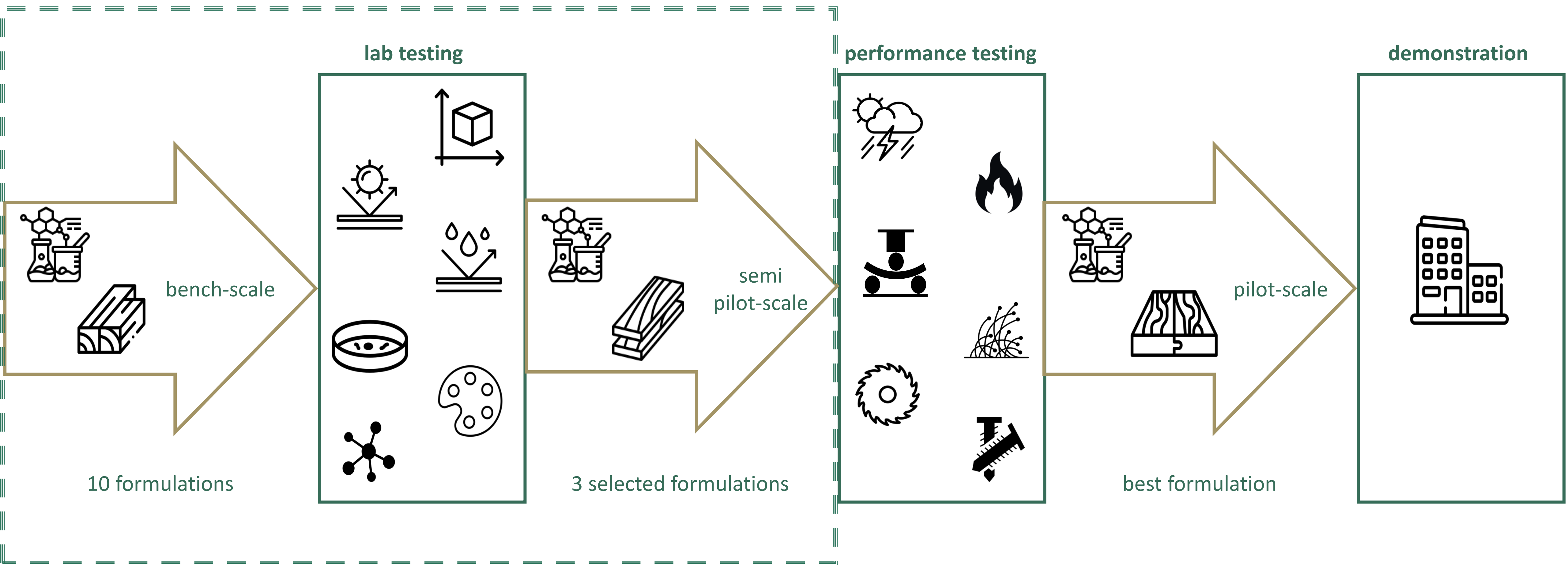
- To characterize the properties of modified wood by multiple testing techniques



- To demonstrate the technical feasibility of the manufacturing line by producing large quantities of modified wood for demo activities and as a raw material for highly durable and sustainable particle boards and to demonstrate circularity



Schema of the workflow



Screening phase



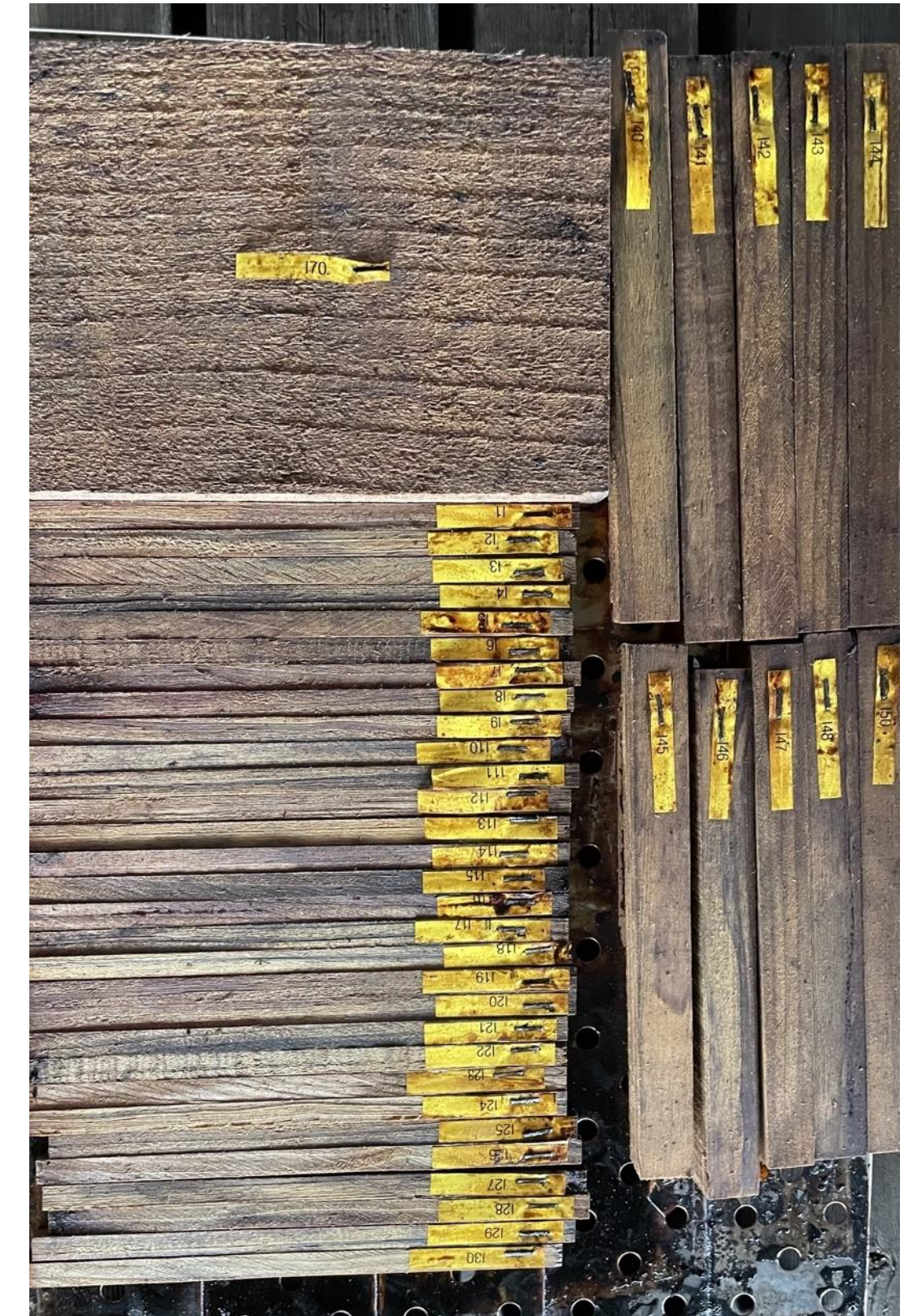
10 formulation



impregnation



curing



modified wood



Stage 1– benchscale impregnations

Two stage production process

- Vacuum pressure impregnation
- Curing in a atmospheric kiln (oven)

Wood species

- Pinus radiata

Sample dimensions (mm)	Amount (pcs)
5 x 10 x 220	30
20 x 20 x 220	11
20 x 150 x 220	1





Impregnation

In industrial wood preservation and modification, the full-cell (to refusal) process is a widely used vacuum-pressure impregnation method designed to maximize the uptake and deep penetration of a preservative or treatment solution into the wood's cellular structure.

In this method, a timber charge is subjected to a sequence of vacuum and pressure stages.

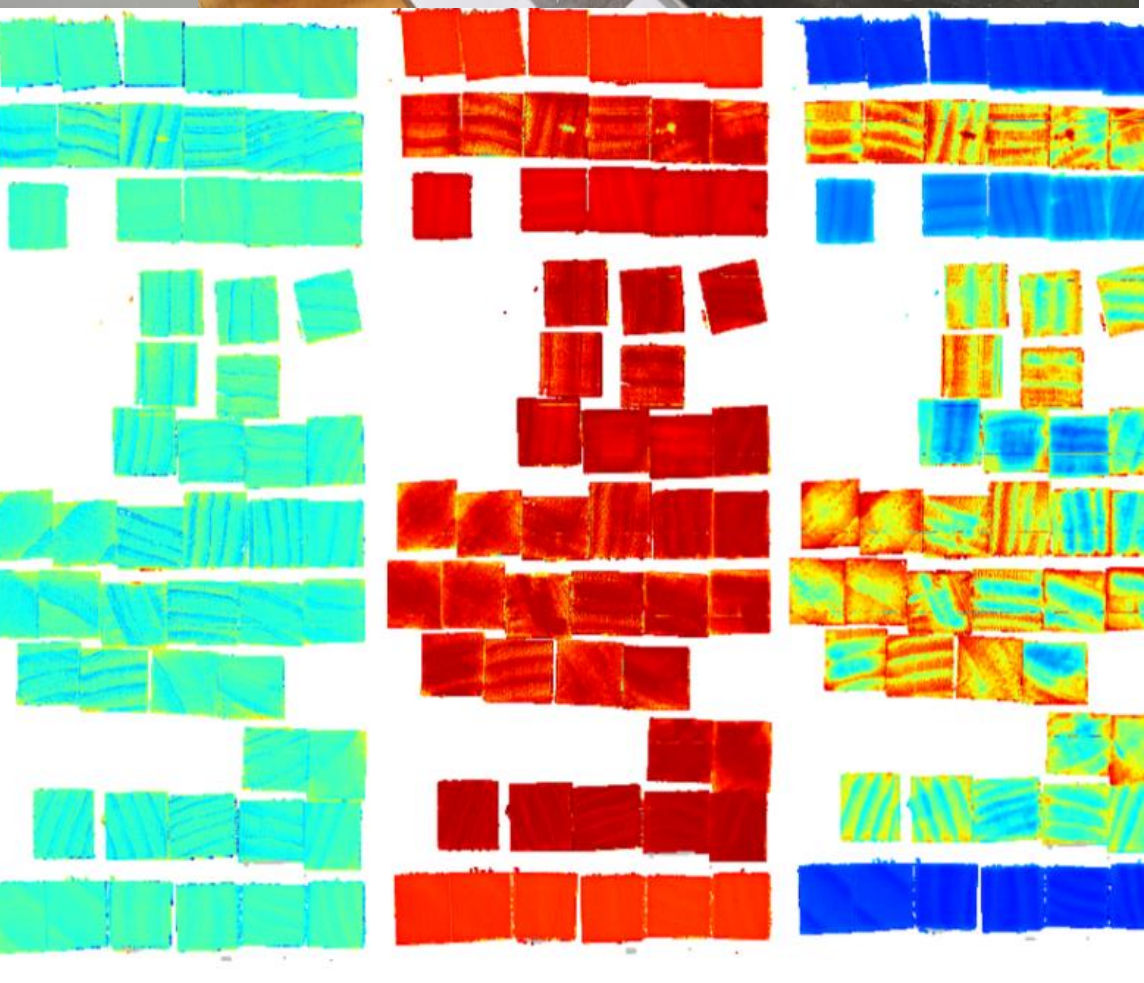
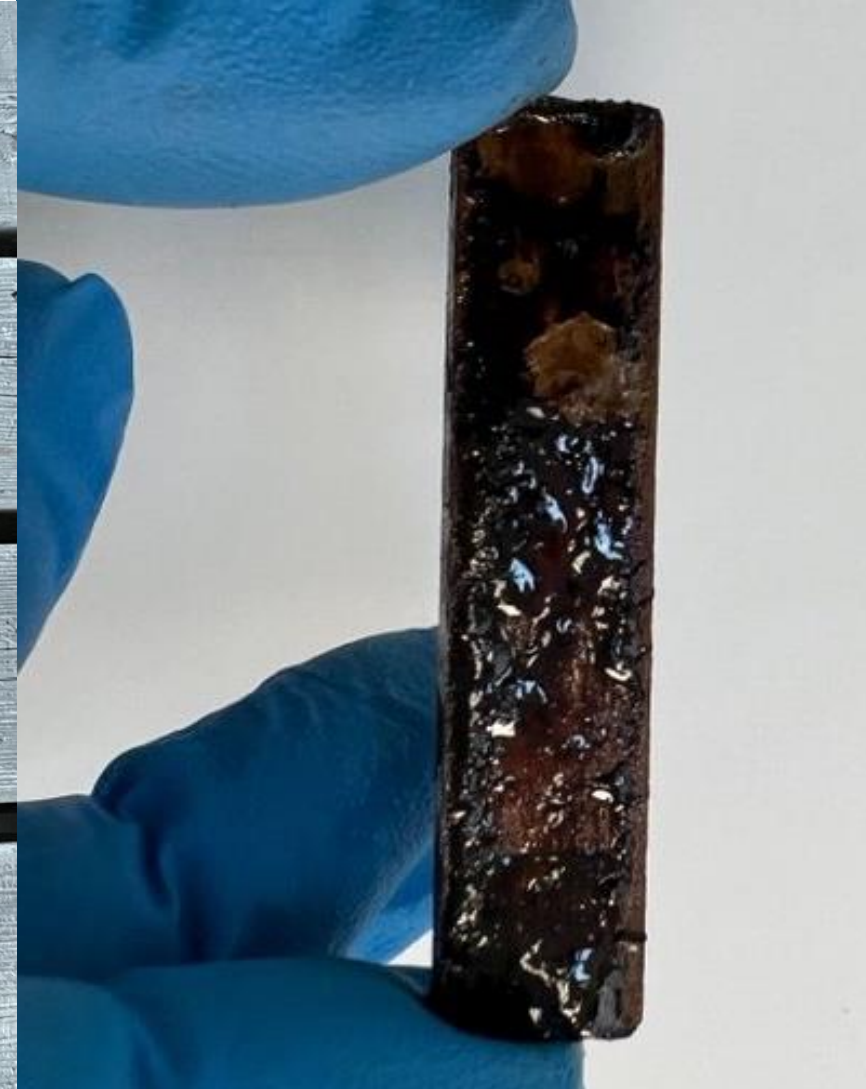
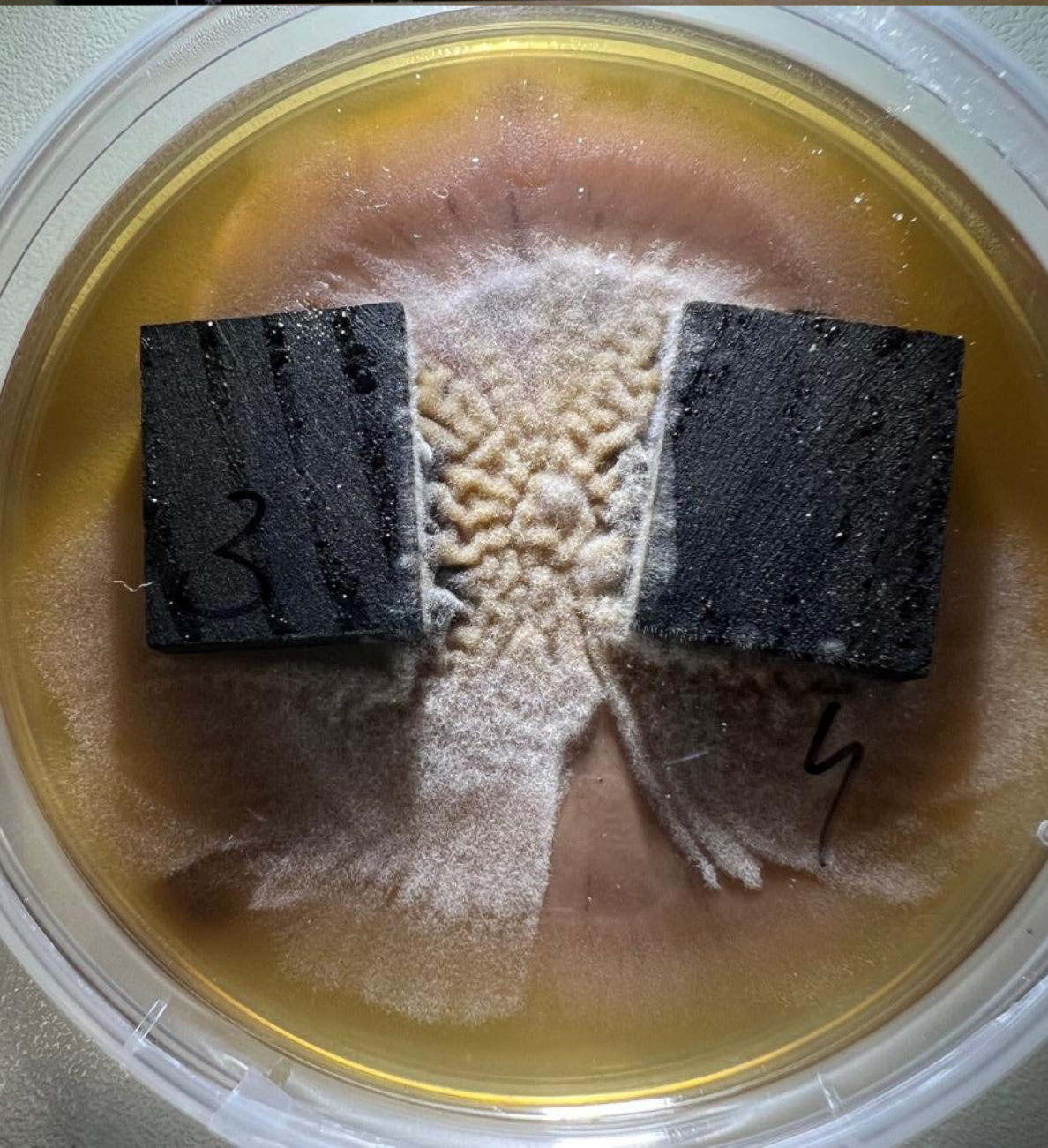
- Pre-vacuum increases accessible pore space and removes barriers to liquid entry. The duration of this phase is 30 minutes and the pressure 20 kPa
- Pressure phase: to refusal ensures deep, uniform filling of wood cells with treatment solution. The duration of this phase is 120 minutes and the pressure 1000 kPa
- Post-vacuum: refines retention and minimizes surface excess, improving treatment quality.

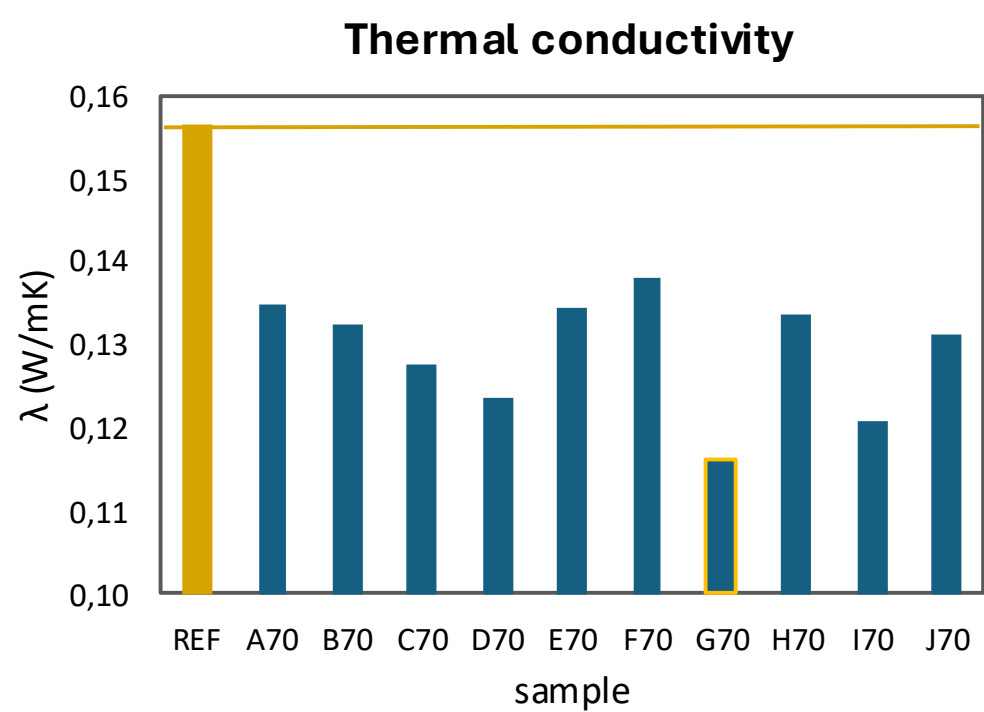
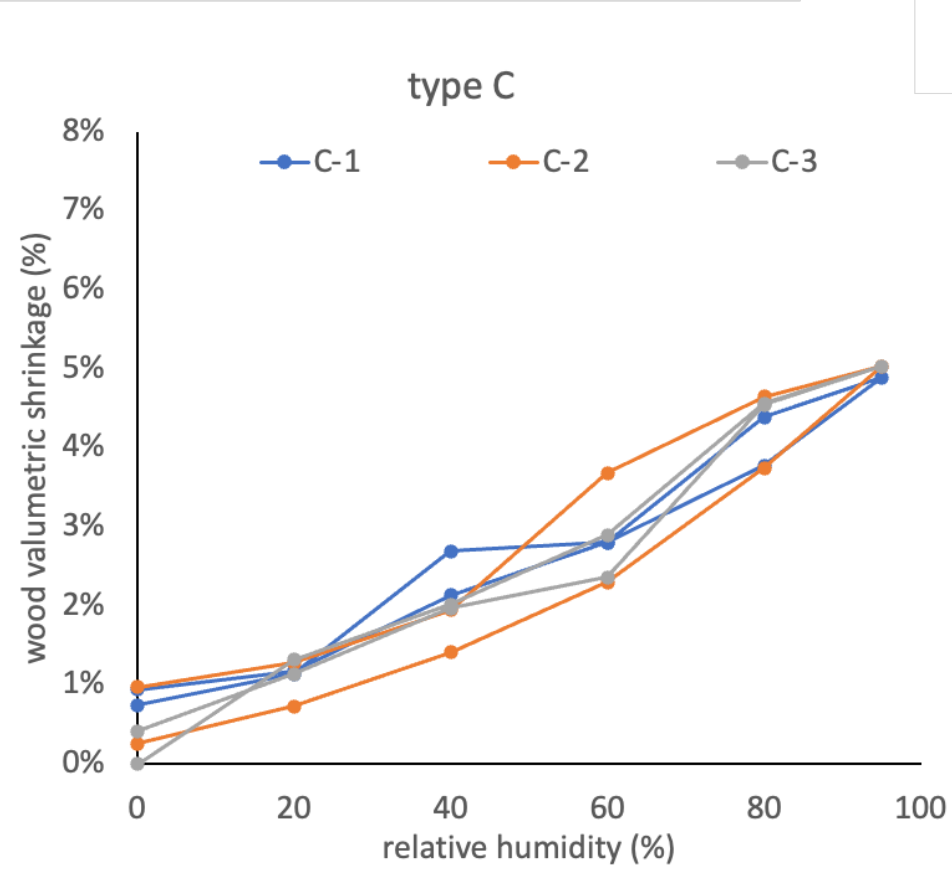
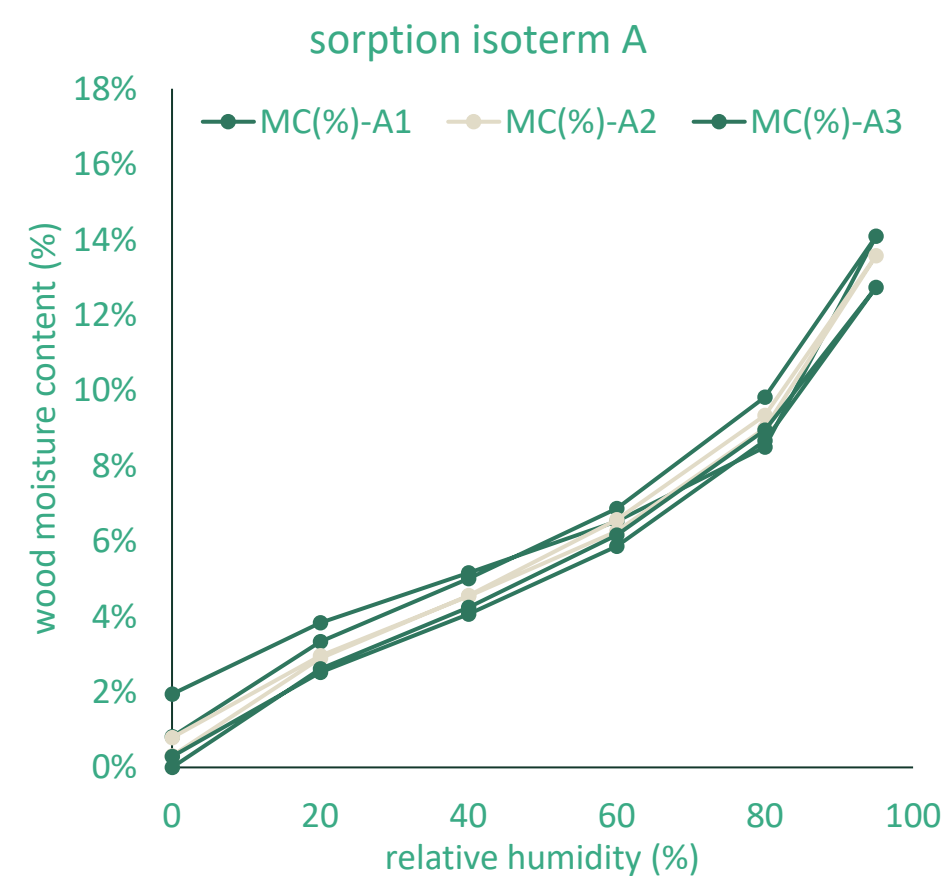
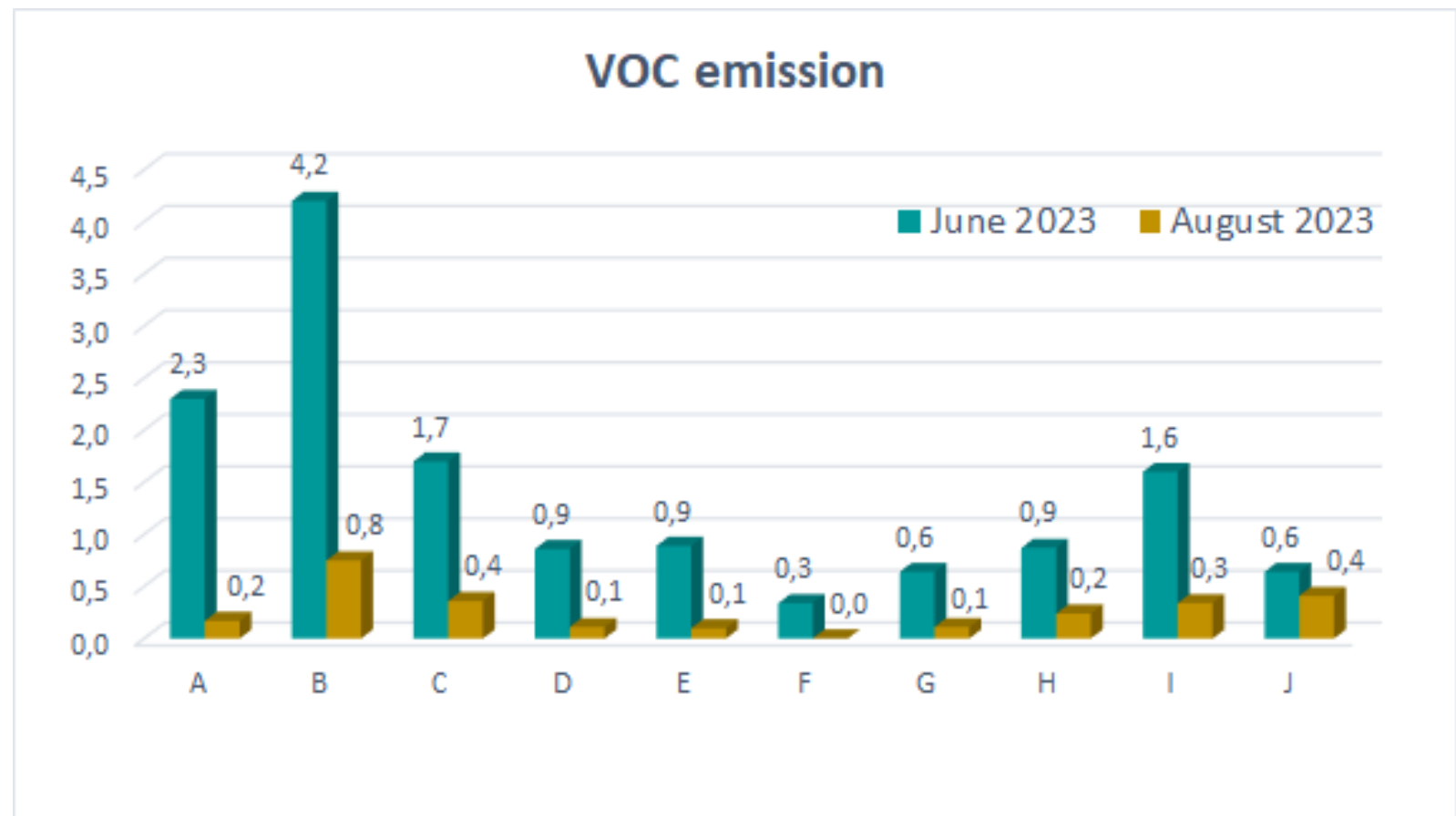
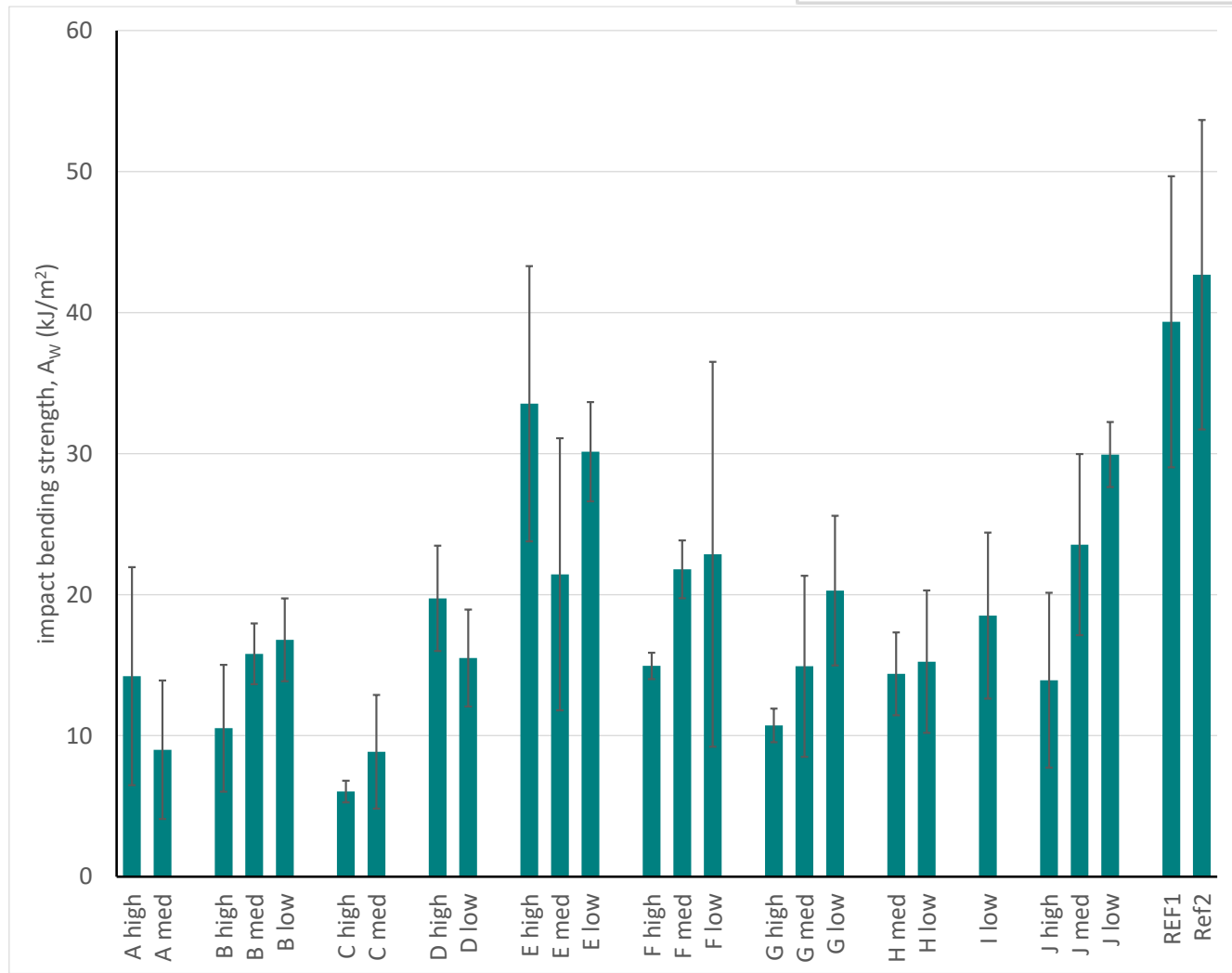
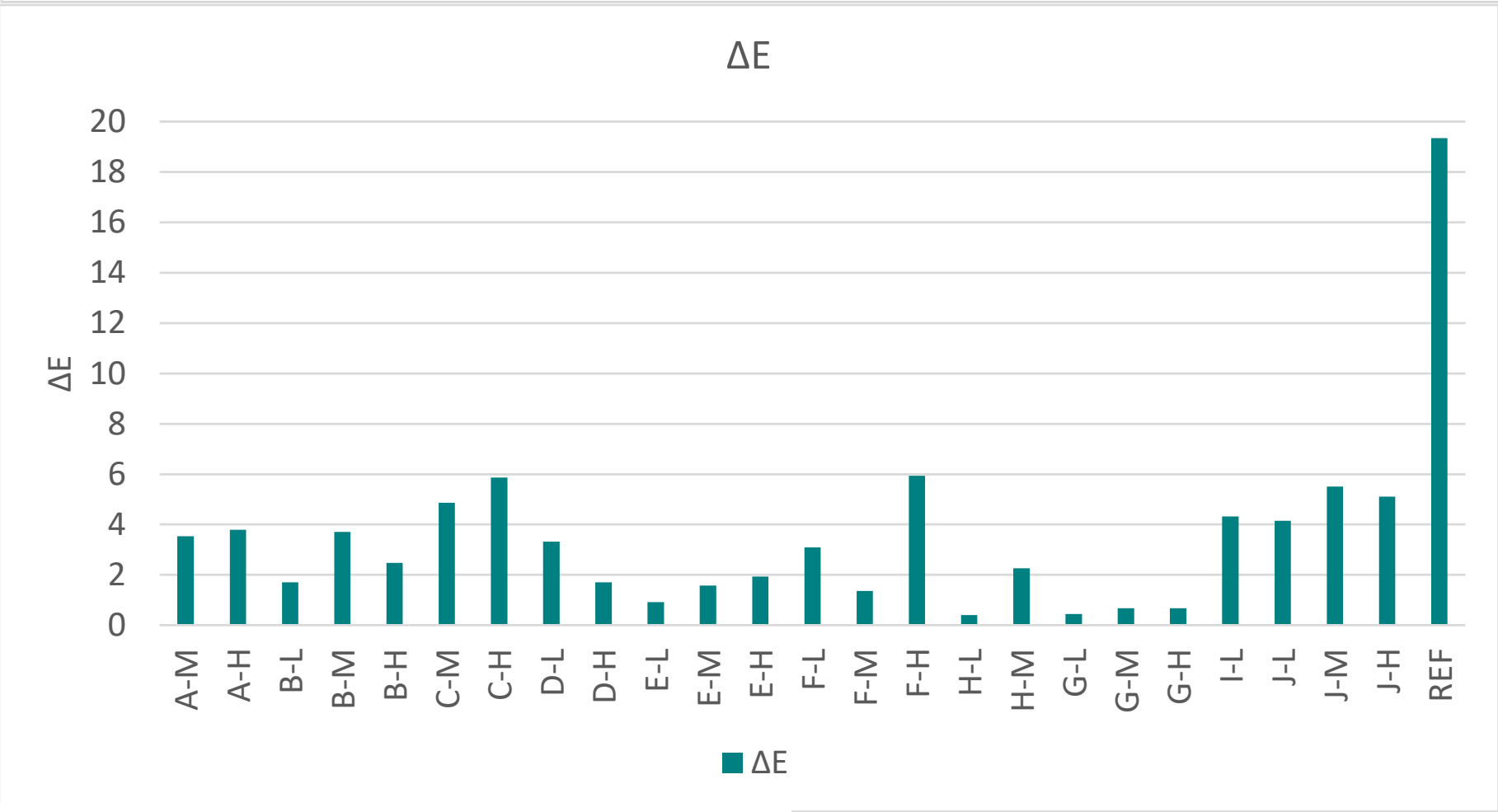
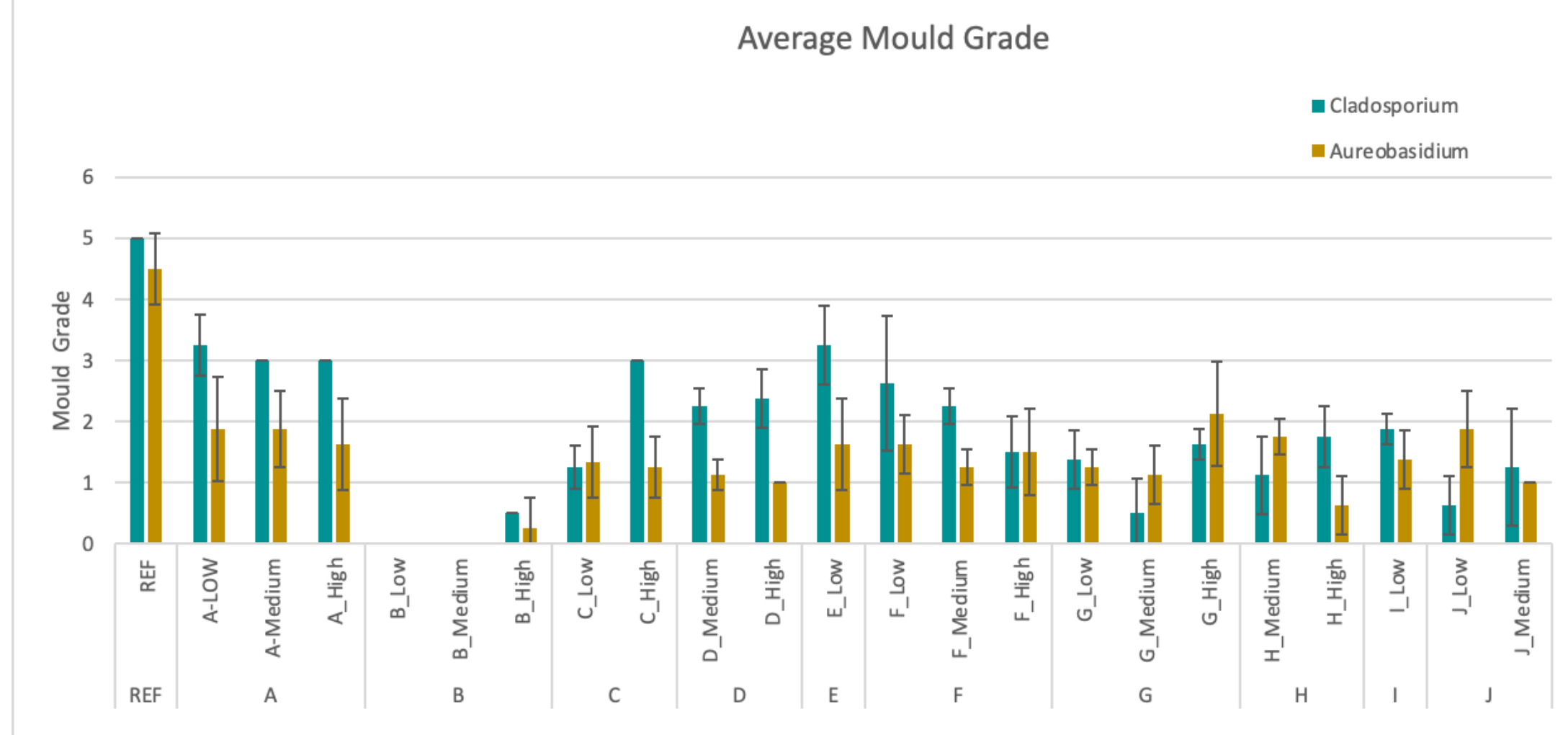
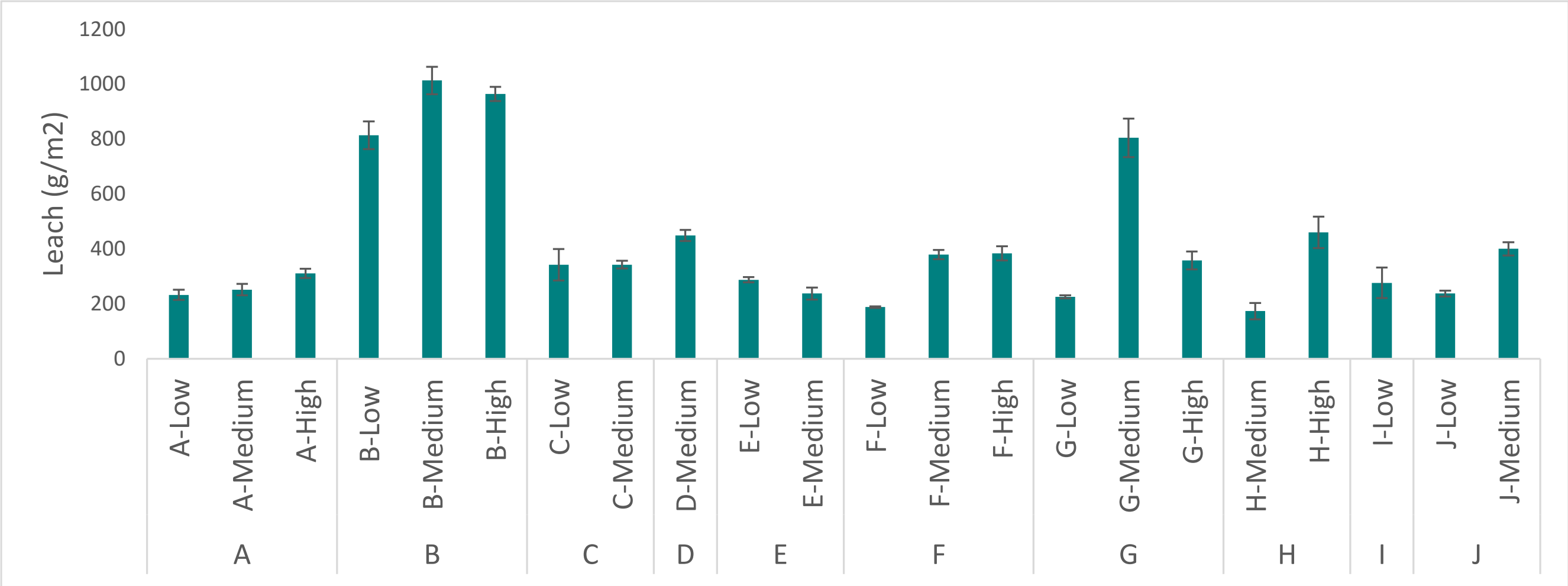
Task 6.3: Description and results



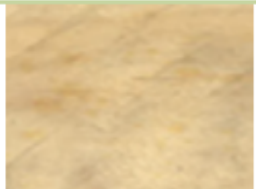
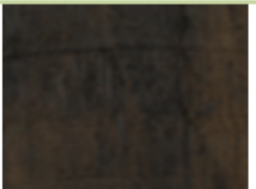
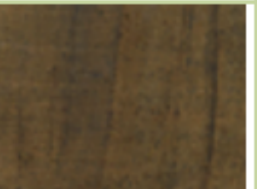
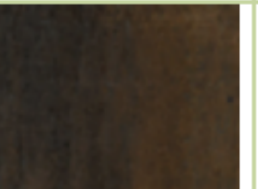
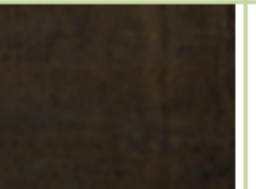
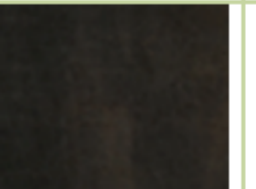
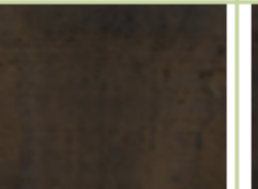
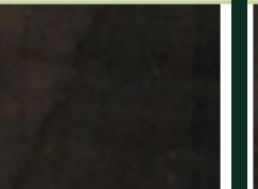
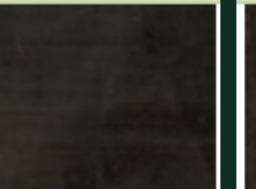
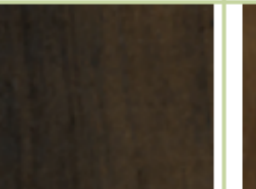
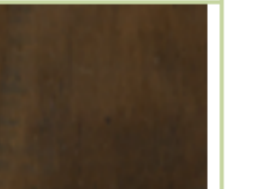
D6.4 Properties of modified wood product

Activity/characterization method	Status
Preparation of specimens for various tests	completed
Samples digitalization	completed
Uptake of impregnation liquor	completed
Density	completed
Moisture uptake	completed
Leaching test	completed
Dimensional stability	completed
Mechanical performance – impact bending strength	completed
UV stability	completed
Biological durability	completed
VOCs emission	completed
Wettability	completed
Appearance (color and gloss)	completed
Hyperspectral imaging	completed
Hygroscopic properties	completed
Thermal properties	completed





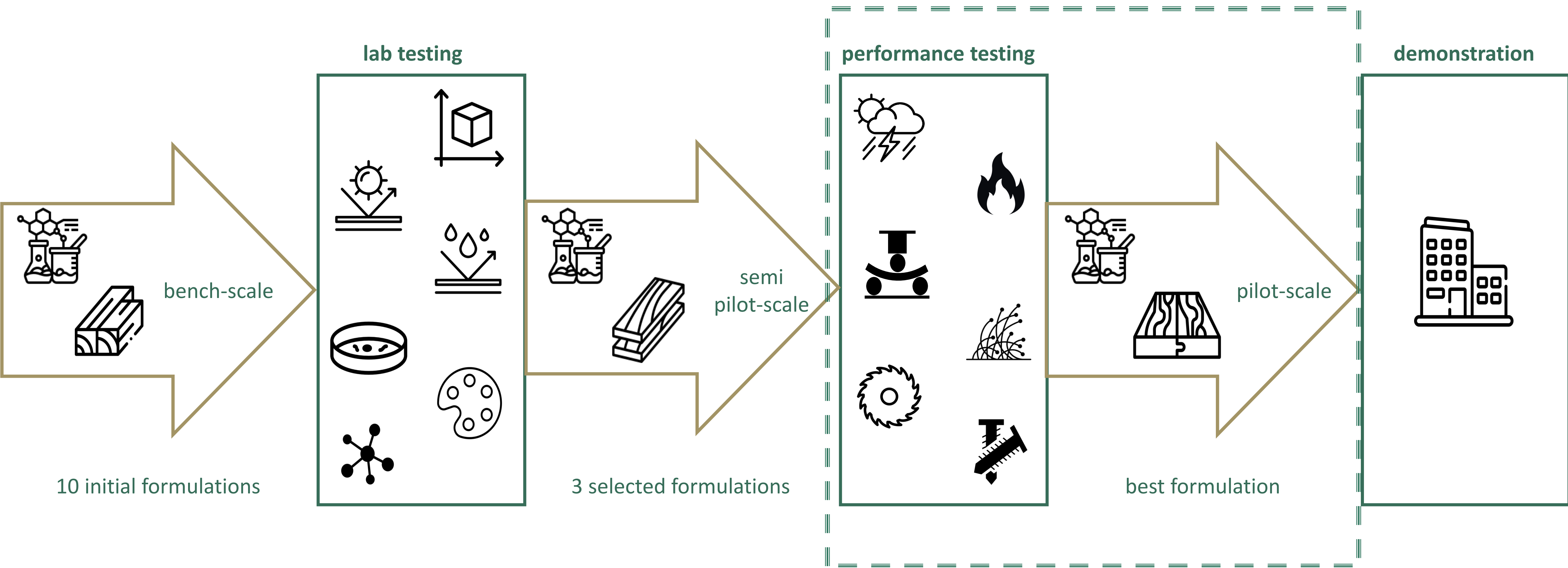
- Main individual compounds:
- Guaiacol
 - Creosol
 - 4-ethyl-2-methoxyphenol
 - Eugenol
 - propylene glycol
 - 1-propoxy-2-propanol
 - Levoglucosan
 - sorbic acid

Characterization method		REF	A	B	C	D	E	F	G	H	I	J
!	Appearance (color)											
	Fixation rate (%)		☹️	😞	😊	☹️	😊	😊	☹️	😊	😊	😊
!	Dimensional stability -volumetric shrinkage (%)		☹️	😊	😊	😊	☹️	☹️	☹️	😊	☹️	☹️
	Hygroscopic properties - EMC at the fibre saturation point (97%RH) (%)		☹️	☹️	☹️	☹️	😊	😊	😊	😊	☹️	☹️
	Impact bending strength (kJ/m²)		☹️	☹️	😞	☹️	😊	☹️	☹️	☹️	☹️	😊
!	Contact angle H ₂ O (°)		😊	😞	😊	😊	😊	😊	😊	😊	😊	☹️
	Surface energy γ_{tot} [mN/m]		😞	☹️	😞	☹️	☹️	☹️	😊	😊	😊	😊
!	UV stability color (ΔE)		☹️	😊	☹️	😊	😊	😊	😊	😊	☹️	☹️
	UV stability gloss (ΔE)		😊	😊	😊	😊	😊	😊	😊	😊	☹️	☹️
!	Durability class (<i>Rhodonia</i>)		😊	☹️	☹️	☹️	☹️	☹️	☹️	😊	☹️	☹️
!	Durability class (<i>Trametes</i>)		😊	☹️	☹️	☹️	😊	☹️	☹️	😊	☹️	😊
	Mold index (<i>Cladosporium</i>)		☹️	😊	☹️	☹️	☹️	☹️	😊	☹️	☹️	😊
!	Mold index (<i>Aureobasidium</i>)		☹️	😊	😊	😊	☹️	😊	☹️	😊	☹️	😊
	VOCs emission (% reduction)		😊	😞	☹️	😊	😊	😊	😊	☹️	☹️	😞
	Thermal conductivity λ (W/mK)		☹️	☹️	☹️	😊	☹️	☹️	😊	☹️	😊	☹️





Schema of the workflow





Task 6.2: Pilot-scale wood modification

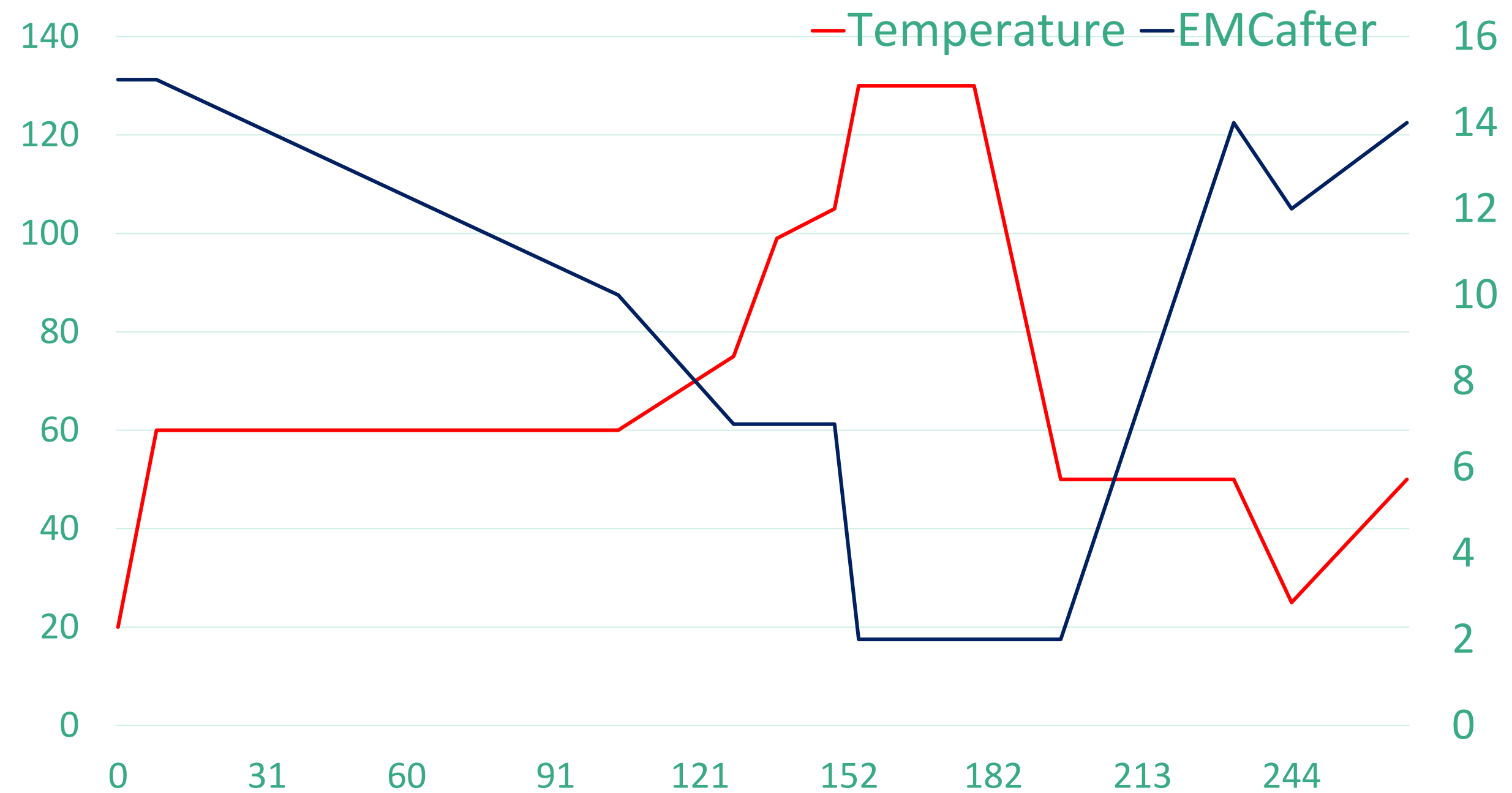
Objective: Optimization of process parameters and demo material production





Pilot scale: Wood modification

- Process: 30min 20kPa; 180 min; 900 kPa; 30 min 20 kPa



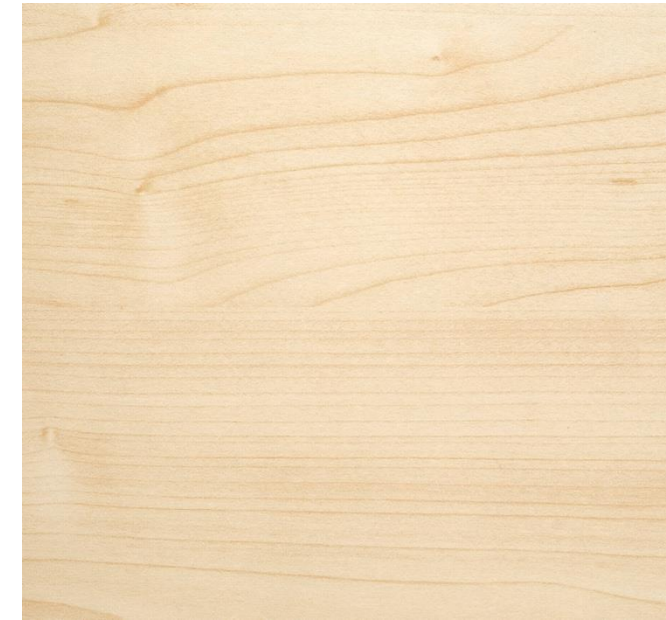
The lowest leaching was observed for curing at 130 °C for 24 hours, which was therefore selected as the optimal condition for the process



Modified wood



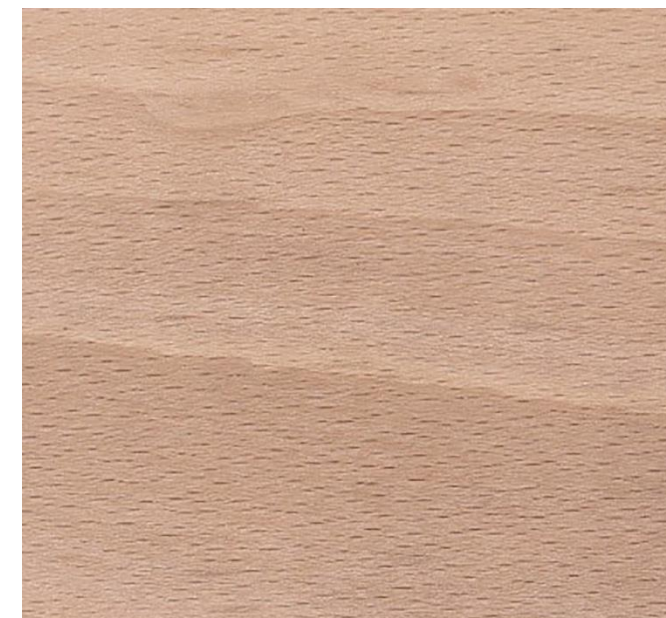
Radiata pine



European beech



Scots pine

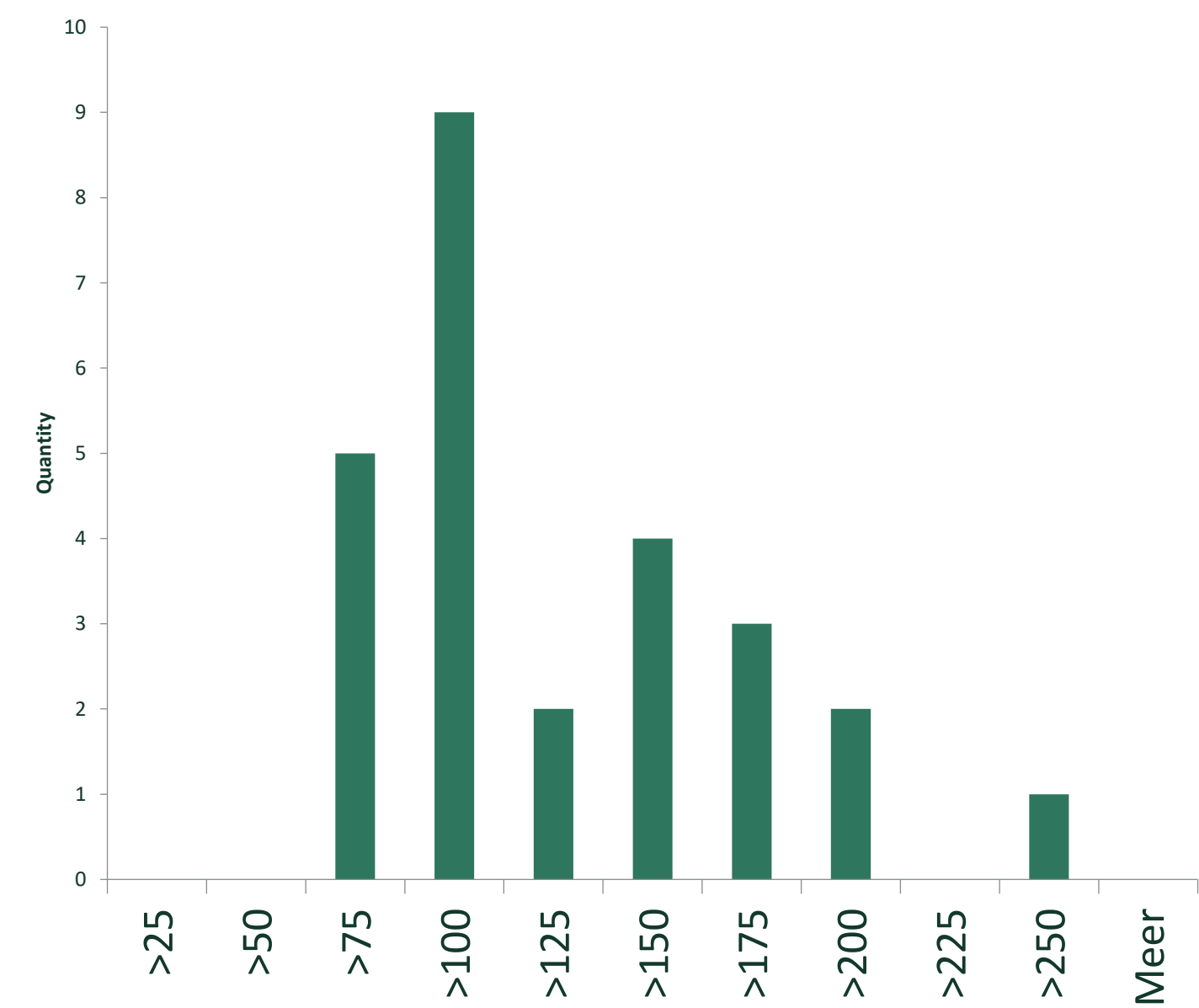


Sycamore maple



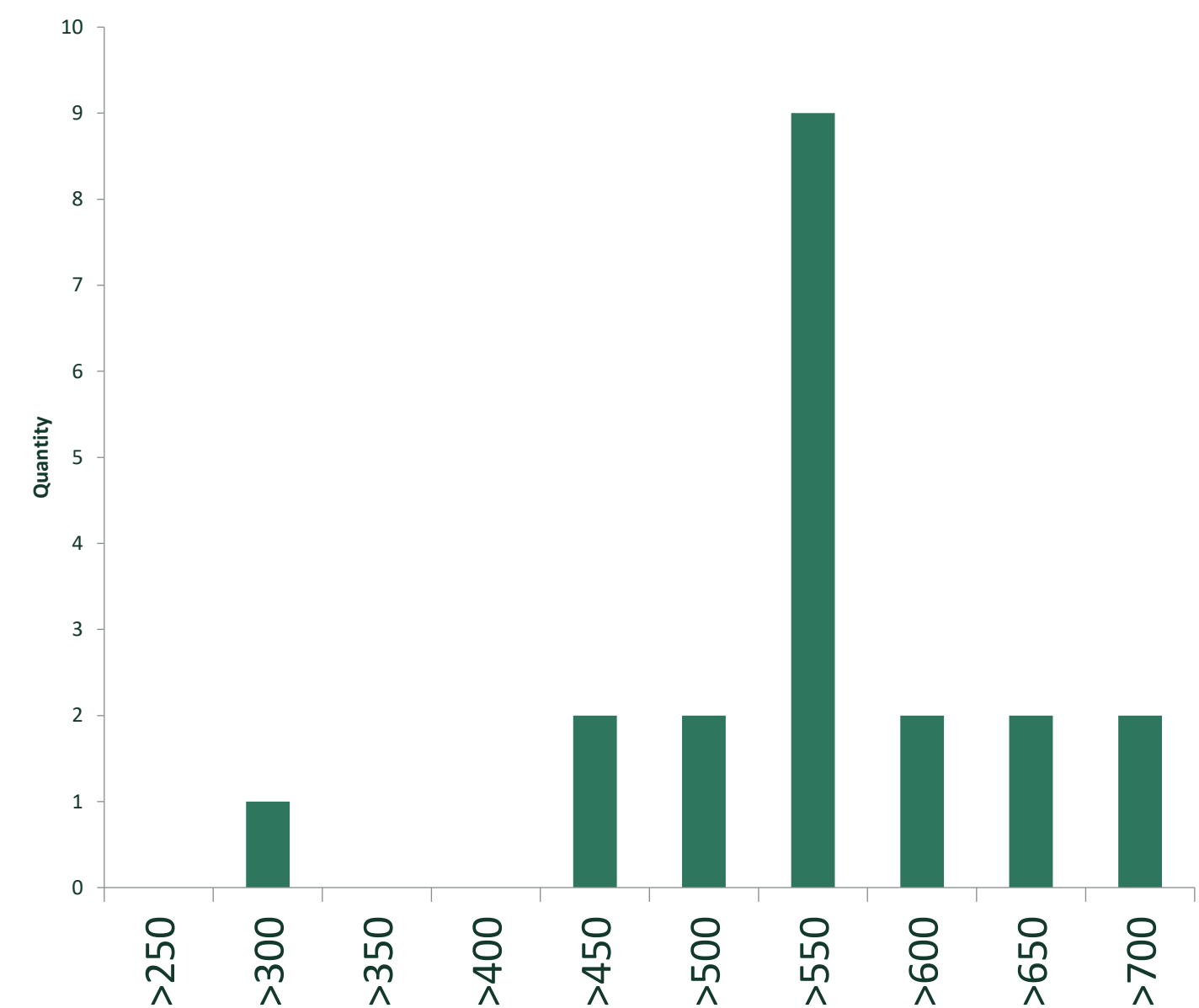
Impregnation results

NE Scots Pine (kg/m3)



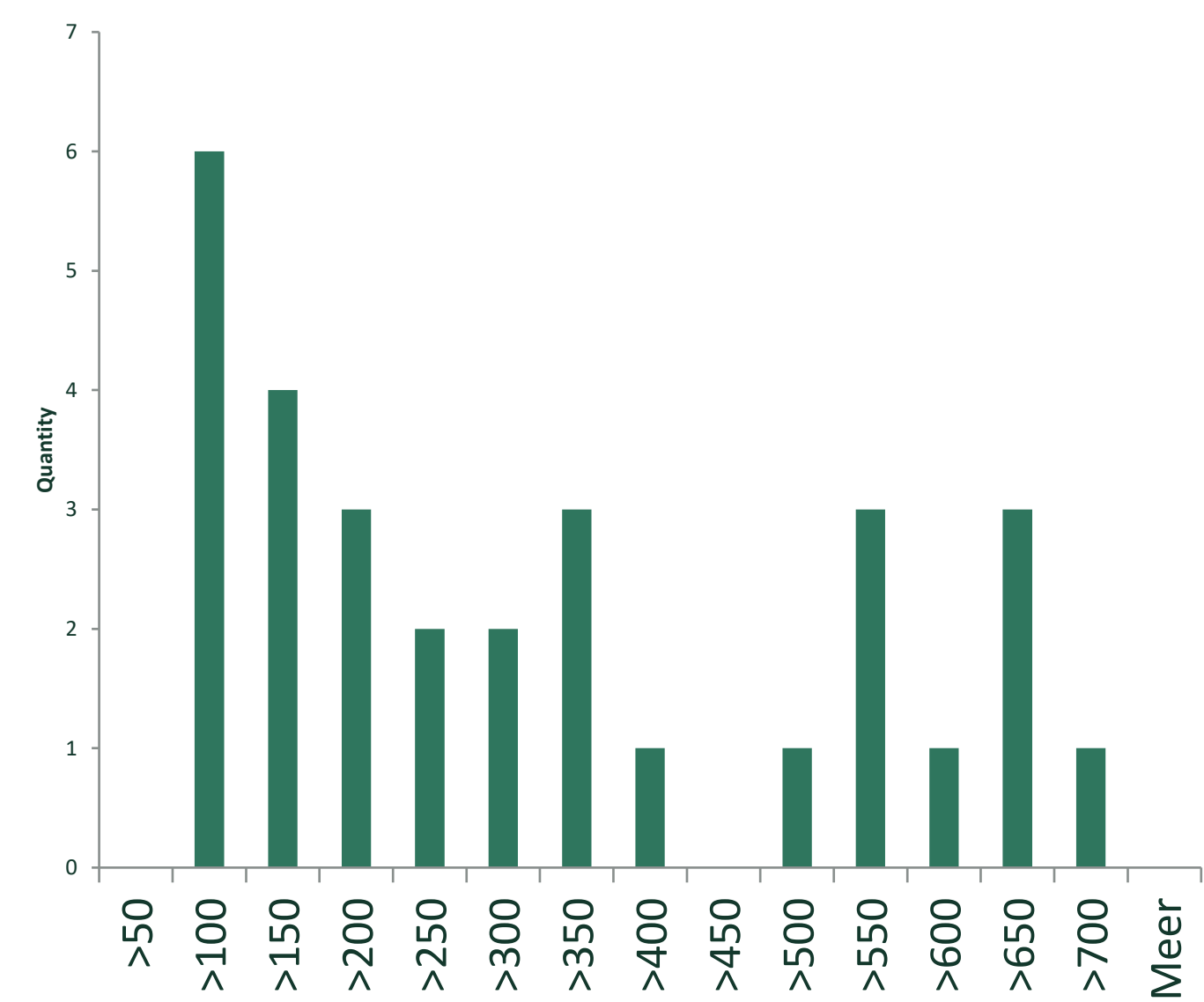
Dimensions	18x145x2100
Average (kg/m3)	113
St.dev	47
N	20

Radiata pine (kg/m3)



Dimensions	25x150x1000
Average (kg/m3)	527
St.dev	89
N	20

Beech



Dimensions	50x100x2200
Average (kg/m3)	309
St.dev	211
N	2055



Impregnation results

- We did not experience any problems with the impregnation solutions
- Initial cutting does not show full sapwood penetration on scots pine
- As expected beech shows high uptake variability
- To increase uptake on European wood species BTG developed low viscosity solution





Task 6.4 Performance-testing of modified wood

Activity/characterization method	Status
Natural weathering EN 927-3	completed
Artificial weathering EN 927-6	completed
Durability tests CEN/TS 15083-1**	completed
Fire tests EN 13823***	completed
Mechanical testing - impact bending strength ISO 13061-10	completed
Cytotoxicity	completed
In filed testing EN 252	completed
Machinability EN 14915	completed
Suitable mounting EN 14915	completed

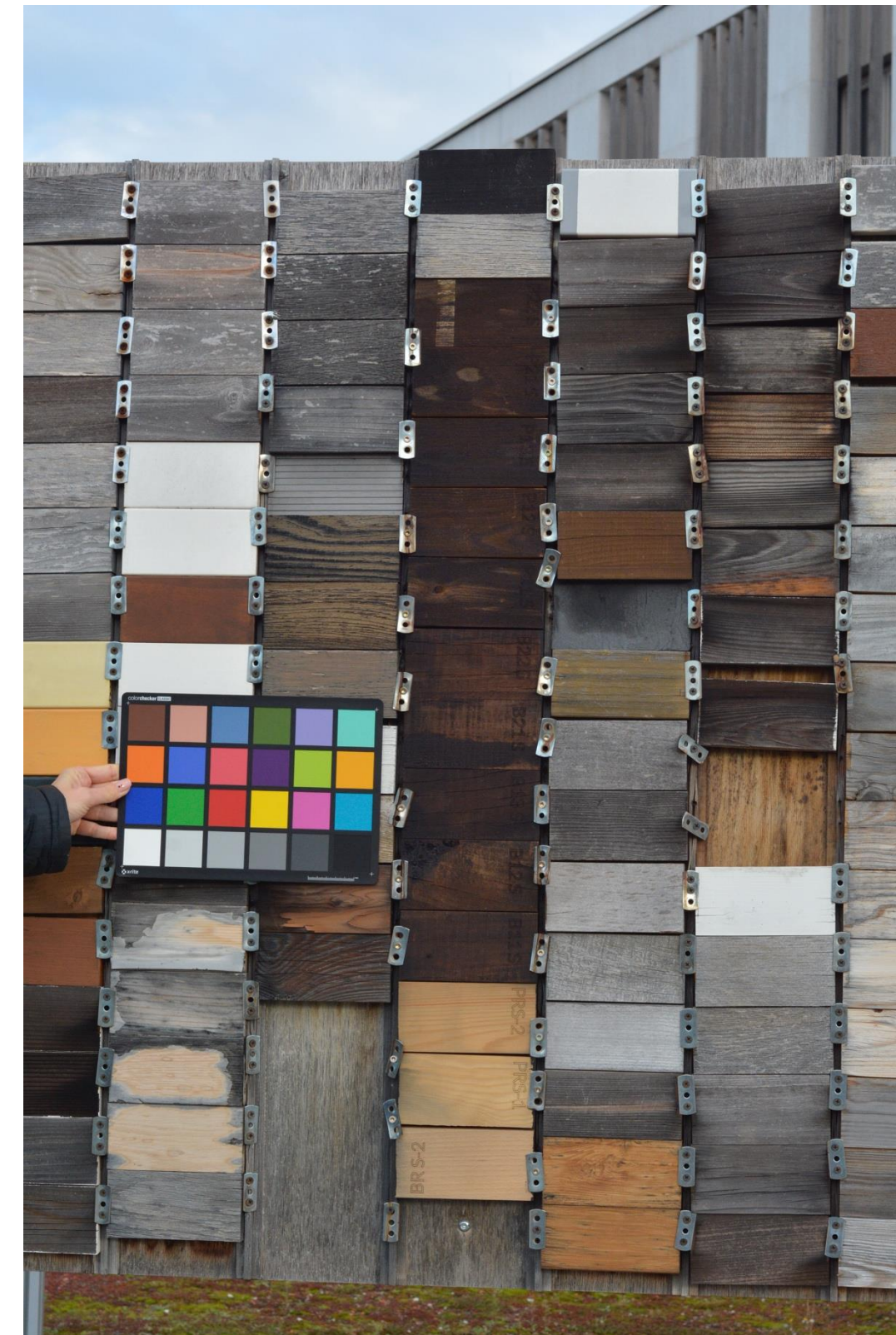
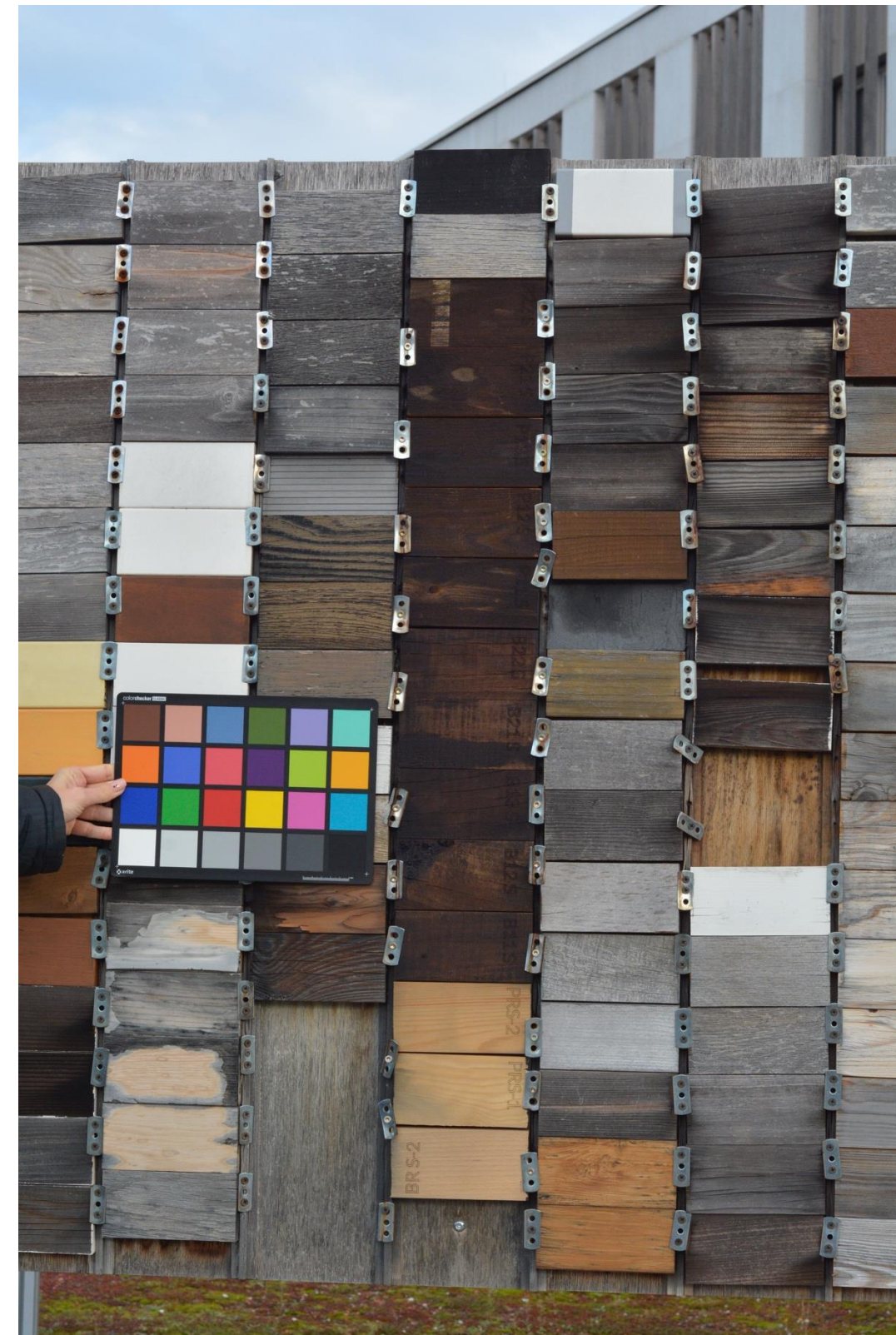


Natural weathering EN 927-3





Progress of the apperance





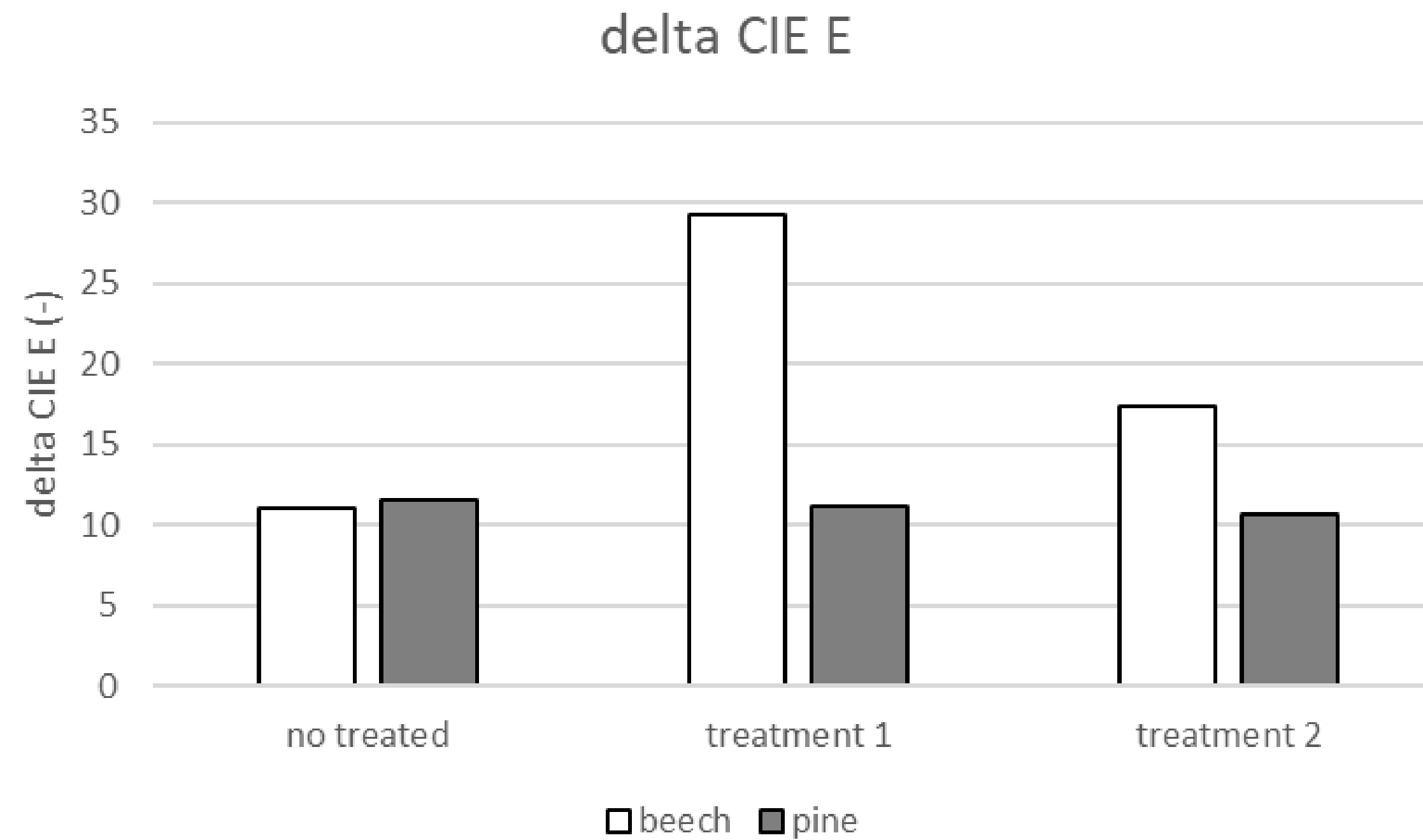
Artificial weathering EN 927-6 – 120 cycles





Colour change

$$\Delta E = \sqrt{\Delta L^{*2} + \Delta a^{*2} + \Delta b^{*2}}$$





Biological durability – CEN 15083





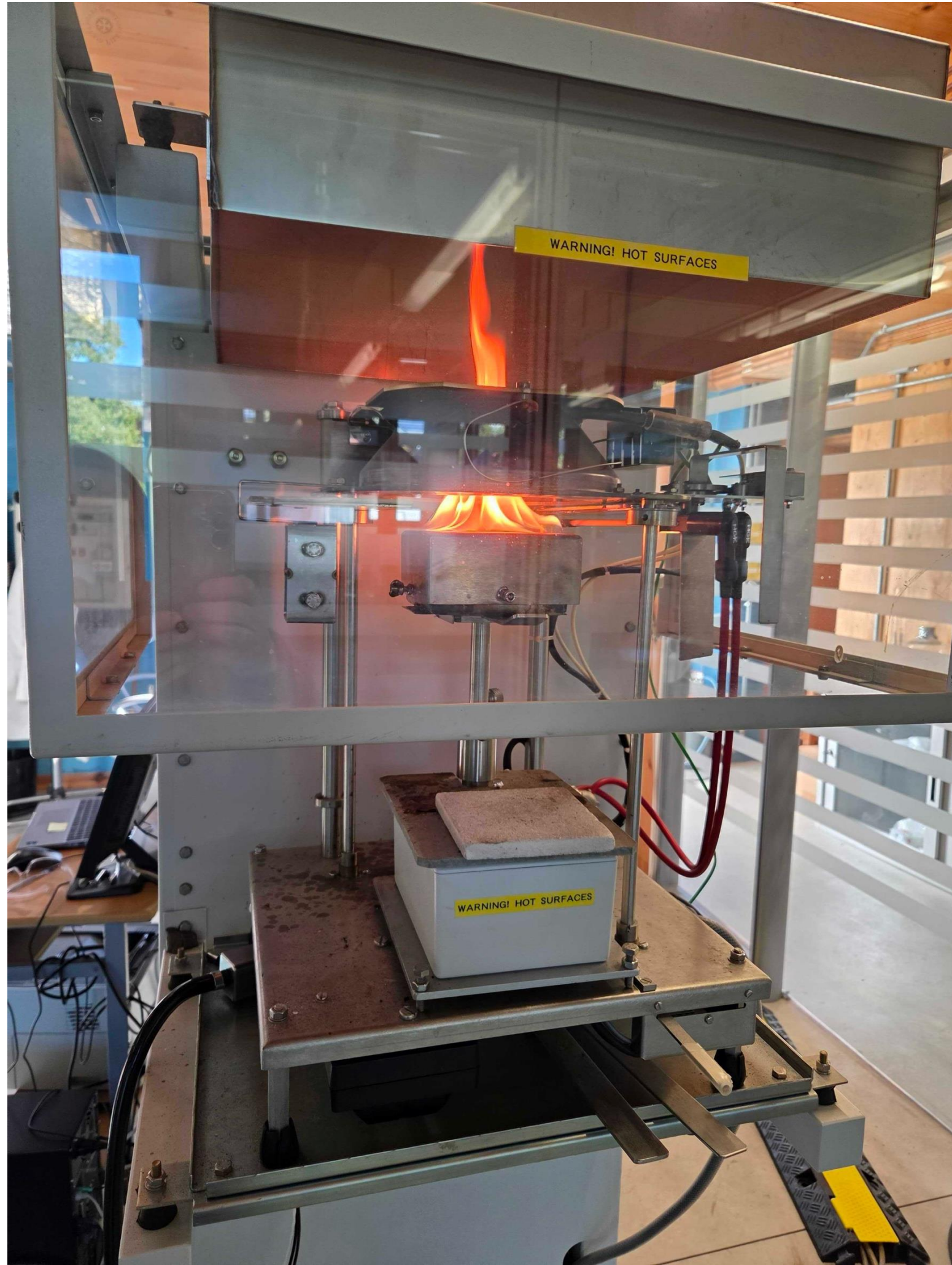
Durability - White rot (*Trametes versicolor*)

Scots pine	Median ML (%)	%DC1	%DC2	%DC3	%DC4	%DC5	DC
Untreated	25,76%	0,00%	0,00%	0,00%	100,00%	0,00%	DC 4
Treated	6,65%	46,67%	20,00%	20,00%	13,33%	0,00%	DC 1

Radiata pine	Median ML (%)	%DC1	%DC2	%DC3	%DC4	%DC5	DC
Untreated	34,58%	0,00%	0,00%	0,00%	20,00%	80,00%	DC 5
Treated	2,68%	80,00%	13,33%	3,33%	3,33%	0,00%	DC 1

European beech	Median ML (%)	%DC1	%DC2	%DC3	%DC4	%DC5	DC
Untreated	51,58%	0,00%	0,00%	0,00%	0,00%	100,00%	DC 5
Treated	8,59%	43,33%	10,00%	13,33%	6,67%	26,67%	DC 1

Fire testing



Cone Calorimeter Test Report

Laboratory name	CNR IBE LABORATORIO REAZIONE AL FUOCO
Operator	Marco Fellin
Filename	C:\CC5\DATA\25100001.CSV
Report name	testPine
Sample description	trial pine
Material name/ID	

Specimen information

E	13.1 MJ/kg	Specimen number	1	Conditioned?	Yes
Thickness	50 mm	Nominal duct flow rate	24 l/s	Temperature	23°C
Initial mass	260.11 g	Edge frame used?	Yes	RH	50%
Surface area	100 cm²	Grid used?	No		
Heat flux	50 kW/m²	Manufacturer			
Separation	25 mm	Sponsor	AnnaSandak		
Orientation	Horizontal				

Test

Standard used	ISO 5660-1
Date of test	06/10/2025
Time of test	13:32
Date of report	05/11/2025

Pre-test conditions

Ambient temperature	18°C
Ambient pressure	100.427 kPa
Relative humidity	60%

Test times

Time to ignition	32 s
Time to flameout	600 s
End of test criterion	User entered
End of test time	600 s
(for calculations)	

Apparatus specifications

C-factor	0.04269
Duct diameter	0.114 m
O2 delay time	15 s
CO2 delay time	15 s
CO delay time	15 s
OD corr. factor	1.0000

Test conditions

Baseline ambient oxygen	20.692%
Baseline oxygen	20.951%
Baseline carbon dioxide	0.0539%
Mass at sustained flaming	259.2 g
Time to 70% mass loss	400 s

Heat Release Results

THR (0-300)	24.97 MJ/m²
THR (0-600)	46.86 MJ/m²
THR (0-1200)	-
Fuel load	1.76 MJ/kg

Test results (between 32 and 600 s)

		Mean	Peak	at time (s)
Total heat release	45.8 MJ/m²	Heat release rate (kW/m²)	79.47	181.39
Total oxygen consumed	34.5 g	Effective heat of comb. (MJ/kg)	12.81	20.93
Mass lost	3606.7 g/m²	Mass loss rate (g/(s·m²))	6.22	15.27
Av. specific MLR ($\dot{m}_{A,10-90}$)	6.14 g/(s·m²)	Specific extinction area (m²/kg)	25.96	97.25
Total smoke release	95.6 m²/m²	Carbon monoxide yield (kg/kg)	0.0048	0.0095
Total smoke production	1.0 m²	Carbon dioxide yield (kg/kg)	1.13	1.90
MARHE	93.3 kW/m²			

Test averages

from ignition to ignition plus...	1 min	2 min	3 min	4 min	5 min	6 min	0 s - 32 s	32 s - 605 s
Heat release rate (kW/m²)	114.54	98.64	91.56	87.98	85.41	83.56	35.32	79.39
Effective heat of comb. (MJ/kg)	16.04	15.13	14.08	13.53	13.34	13.06	11.21	12.79
Mass loss rate (g/(s·m²))	7.39	6.62	6.58	6.53	6.44	6.43	3.33	6.24
Specific extinction area (m²/kg)	66.85	50.56	40.66	35.08	31.61	29.42	110.08	25.85
Carbon monoxide yield (kg/kg)	0.0063	0.0060	0.0056	0.0053	0.0052	0.0050	0.0041	0.0048
Carbon dioxide yield (kg/kg)	1.43	1.35	1.26	1.20	1.19	1.16	0.75	1.12

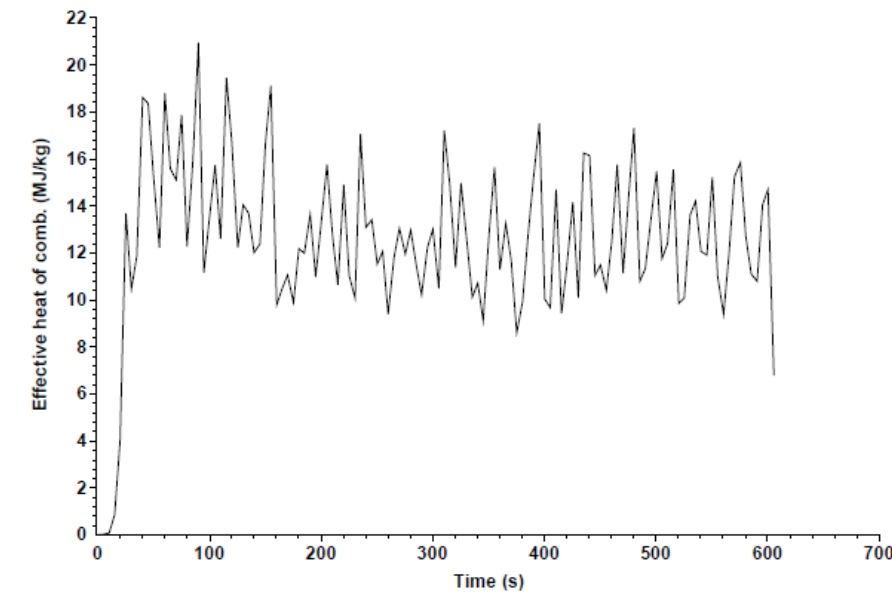
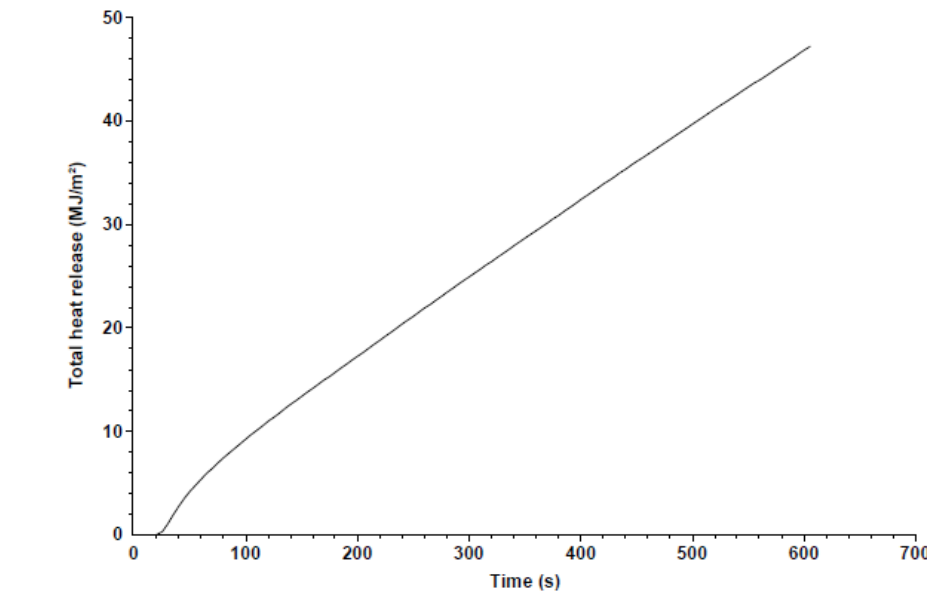
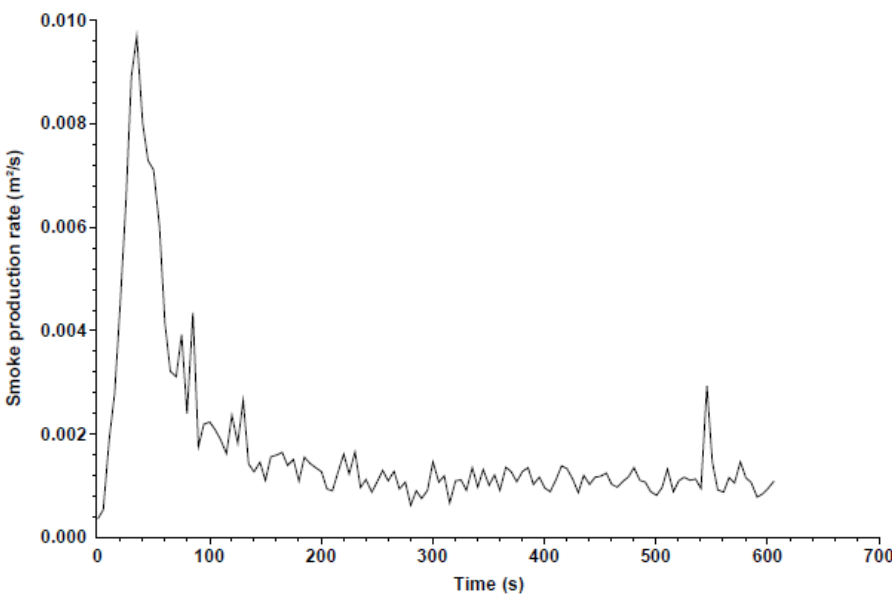
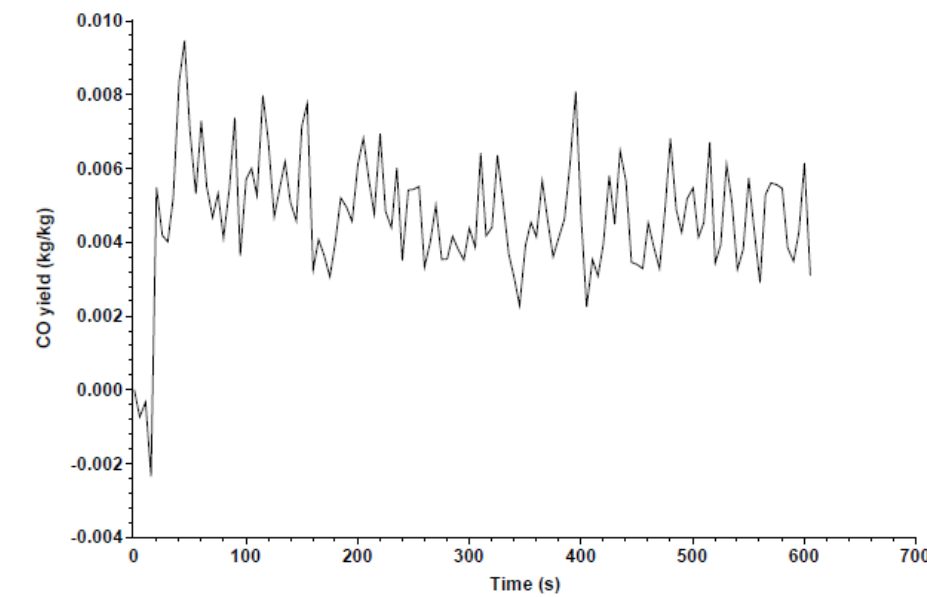
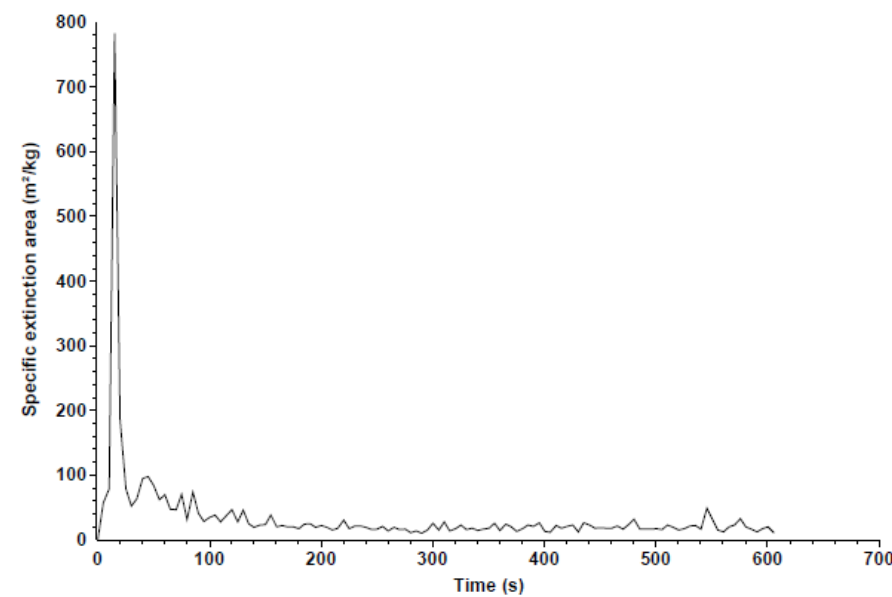
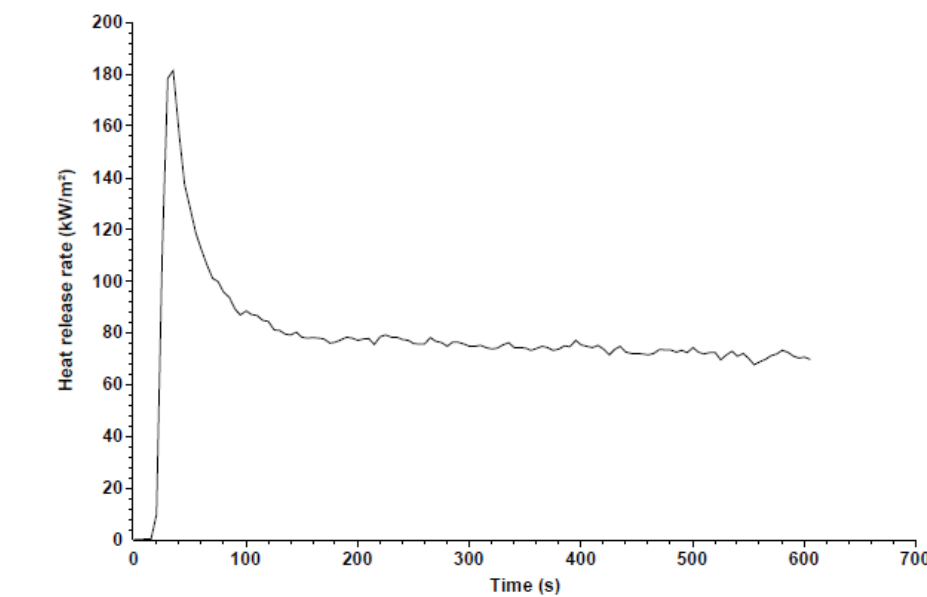
Smoke results

Total smoke release: non-flaming phase (0 s - 32 s)	10.4 m²/m²
Total smoke release: flaming phase (32 s - 600 s)	95.6 m²/m²
Total smoke release: whole test (0 s - 600 s)	106.0 m²/m²

The test results relate to the behaviour of the test specimens of a product under the particular conditions of the test; they are not intended to be the sole criterion for assessing the potential fire hazard of the product in use.

Cone Calorimeter Test Report

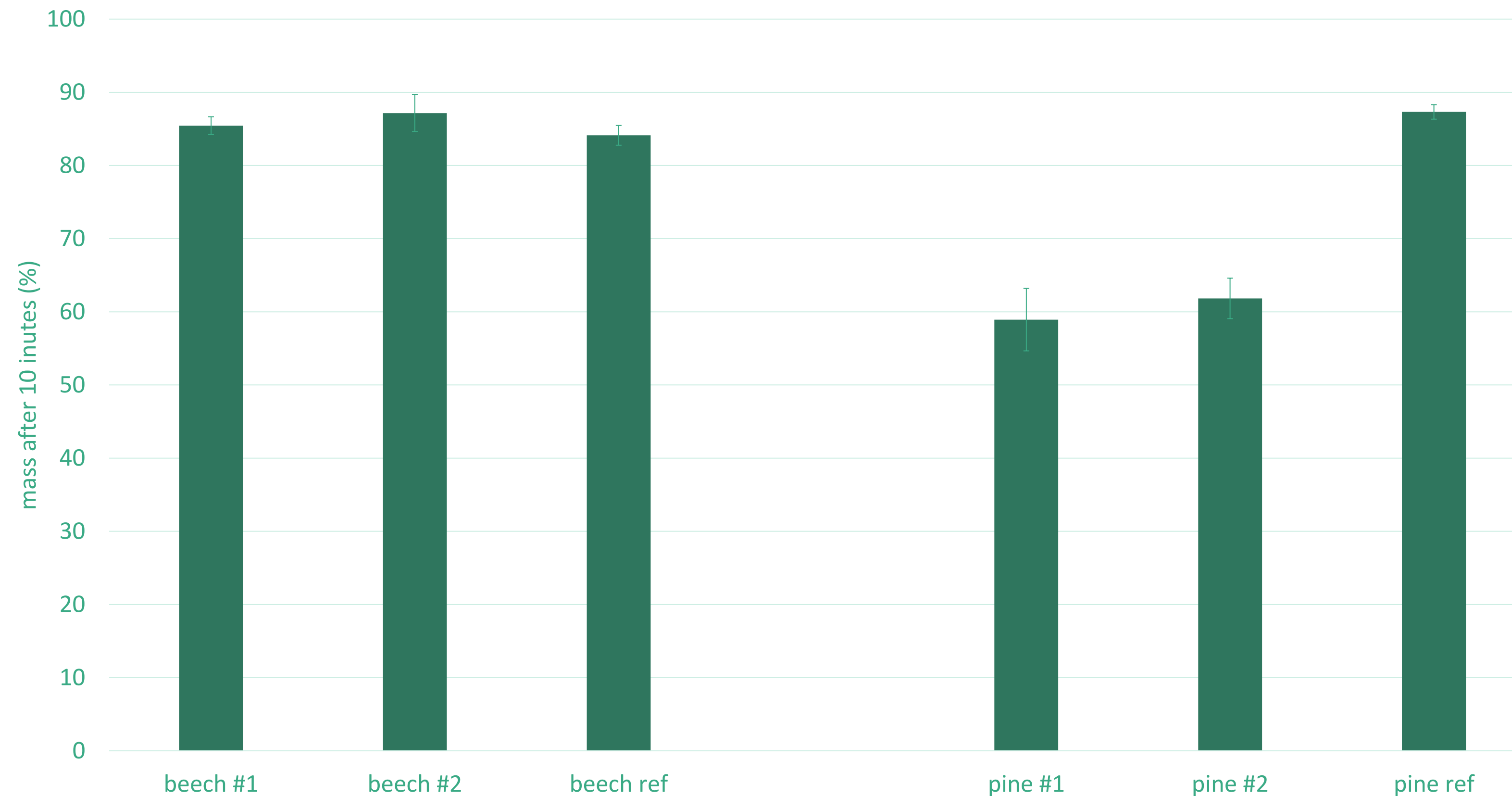
Laboratory name	CNR IBE LABORATORIO REAZIONE AL FUOCO
Operator	Marco Fellin
Filename	C:\CC5\DATA\25100001.CSV
Report name	testPine
Sample description	trial pine
Material name/ID	



The test results relate to the behaviour of the test specimens of a product under the particular conditions of the test; they are not intended to be the sole criterion for assessing the potential fire hazard of the product in use.



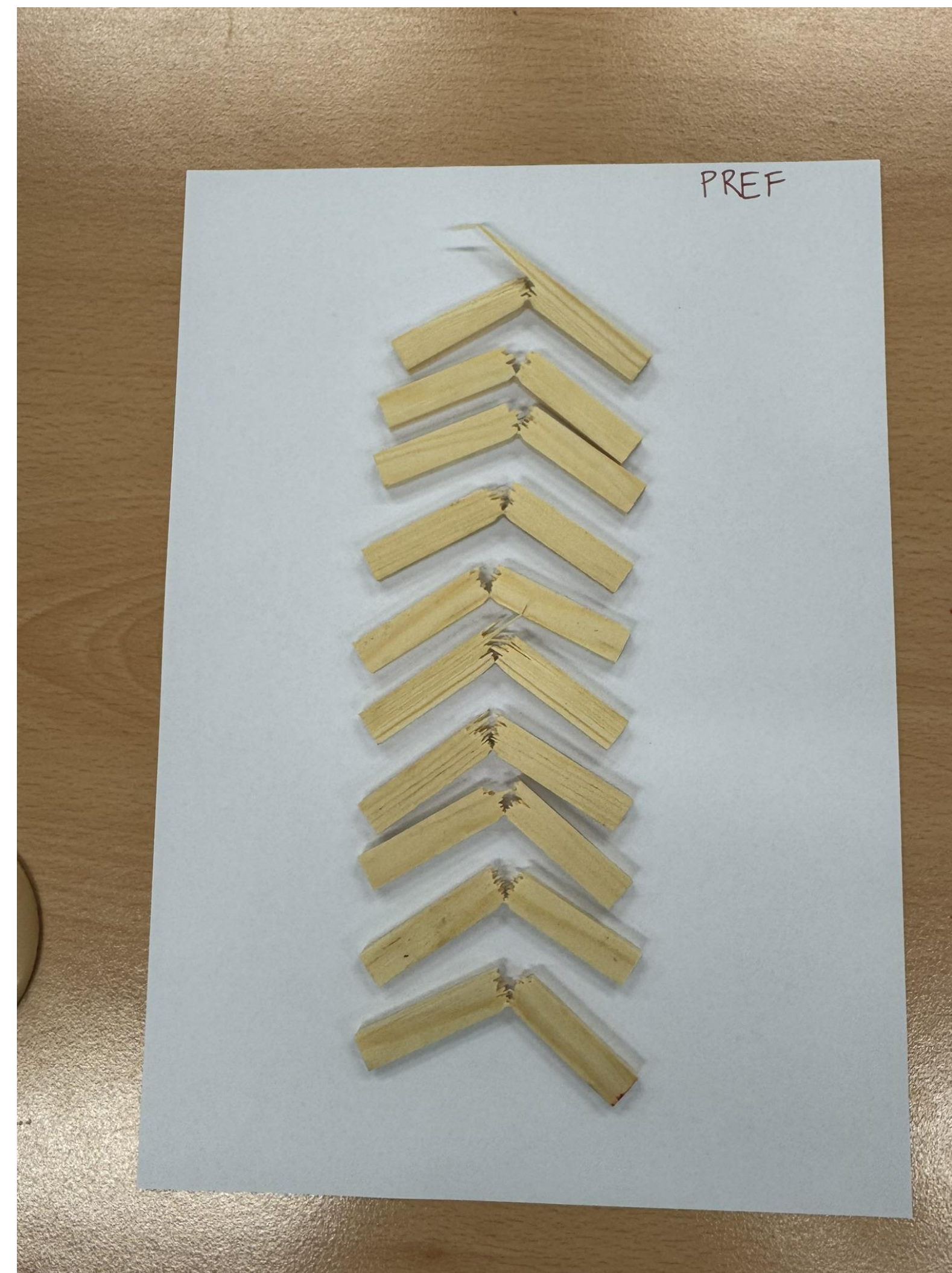
Fire testing: mass remained after 10 minutes (%)



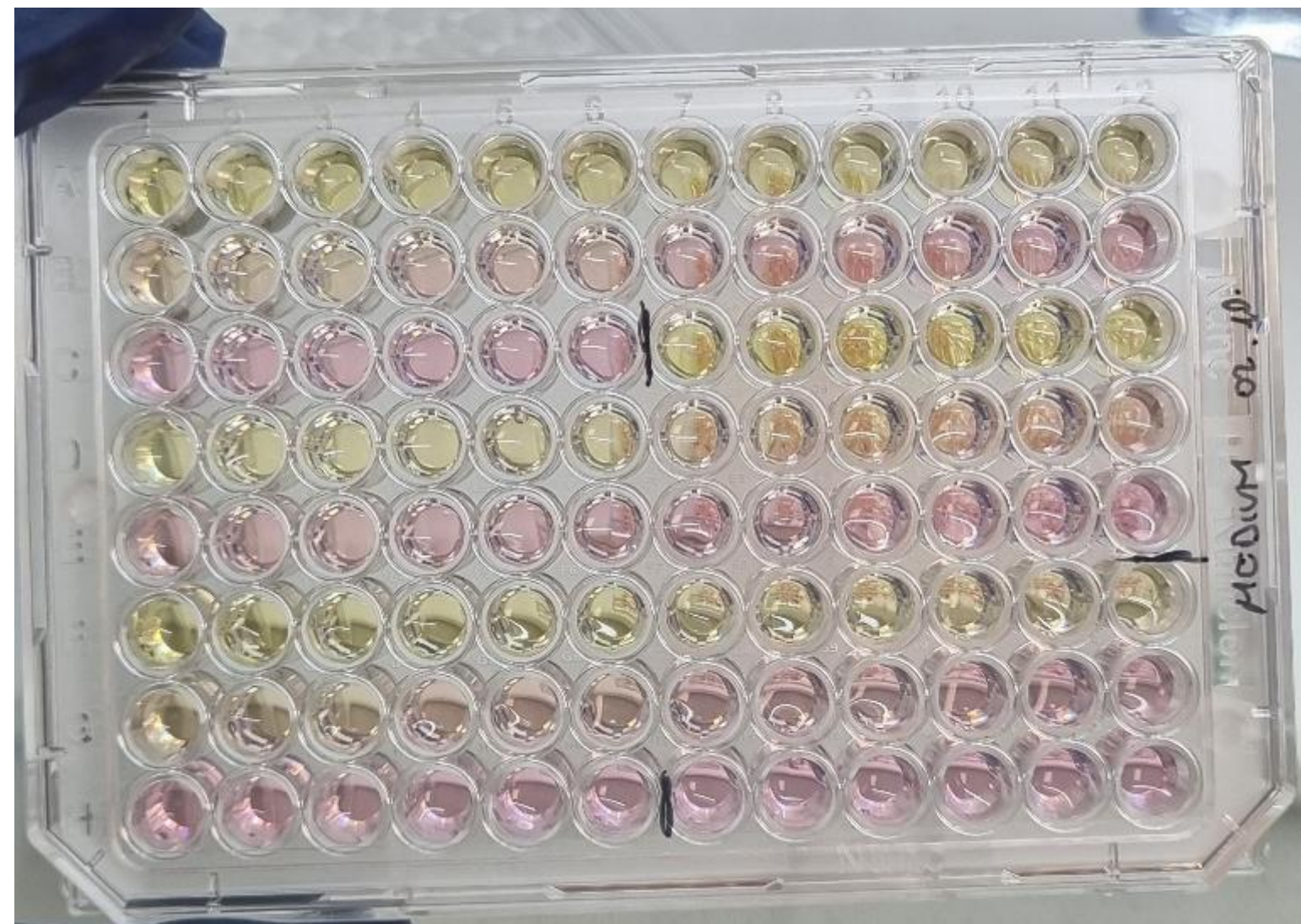
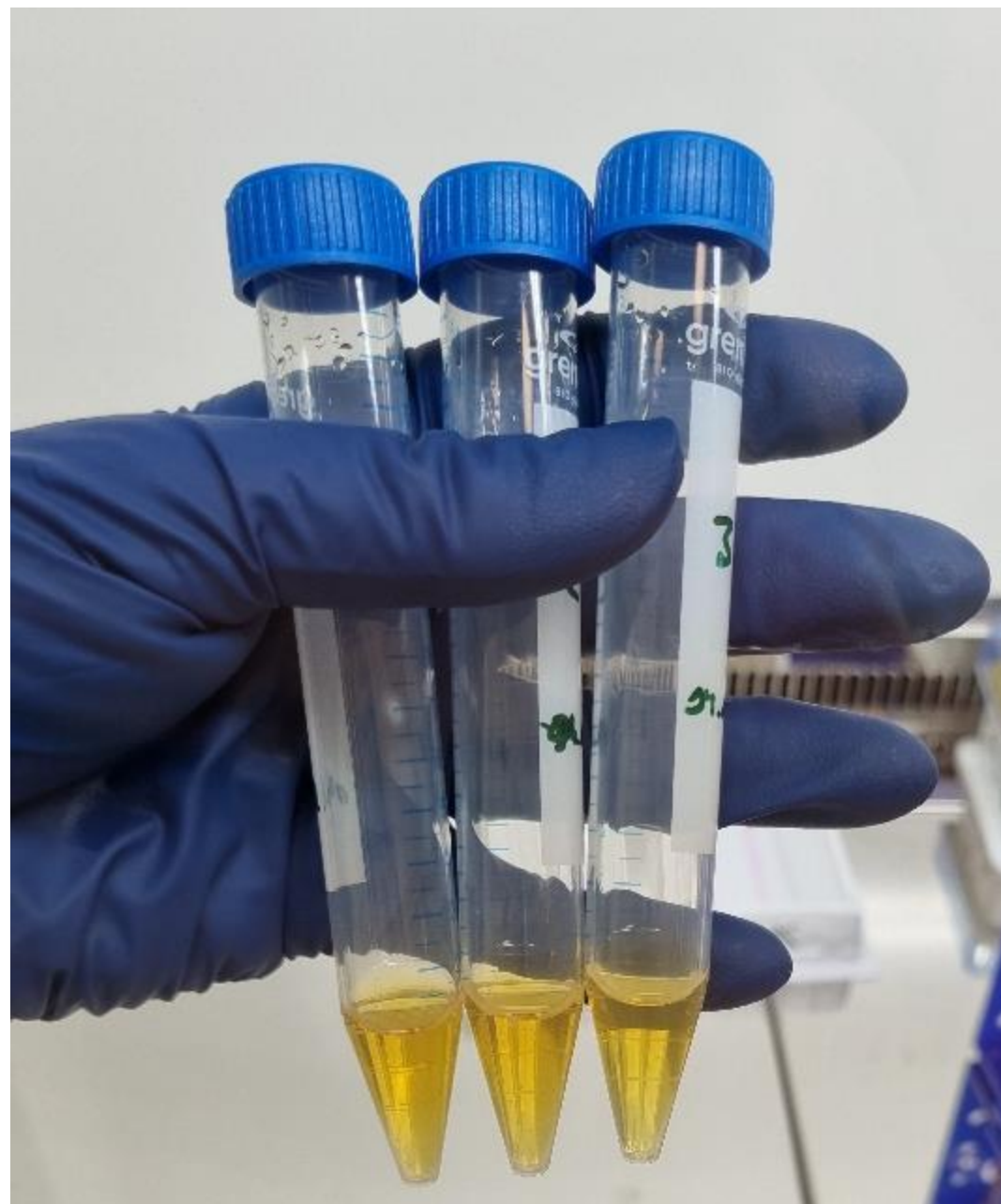
Beech = slower to ignite, retains more mass → better inherent fire behaviour.
Pine = fast ignition, greater mass loss → more flammable, faster degradation.
The modification appears neutral for beech but detrimental for pine in fire performance.



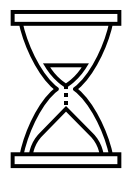
Mechanical testing – ISO 13061-10



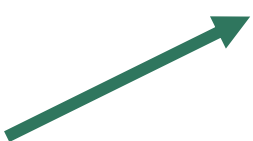
Cytotoxicity



3 types of pyrolysis oils - serial dilutions in triplicates

24 h 

Assessment of viability
(metabolic activity)



Observation of morphology
(microscope)



Concentrations

1	2	3	4	5	6	7	8	9	10
1/8	1/16	1/32	1/64	1/128	1/256	1/512	1/1024	1/2048	1/4096



In filed testing – EN 252





Machinability

Wooden boards impregnated with the pyrolysis oil

Medium-density fibreboards

Plywood panels

Foams

Cross-laminated timber panes glued with the prototype adhesives



Suitable mounting

Mounting tests guided fastening selection for the NewWave mock-up; four configurations were evaluated. Siding was fixed with conventional screws, inserted from the non-visible side to prevent corrosion and discoloration; softwood spacers ensured stability and ventilation.

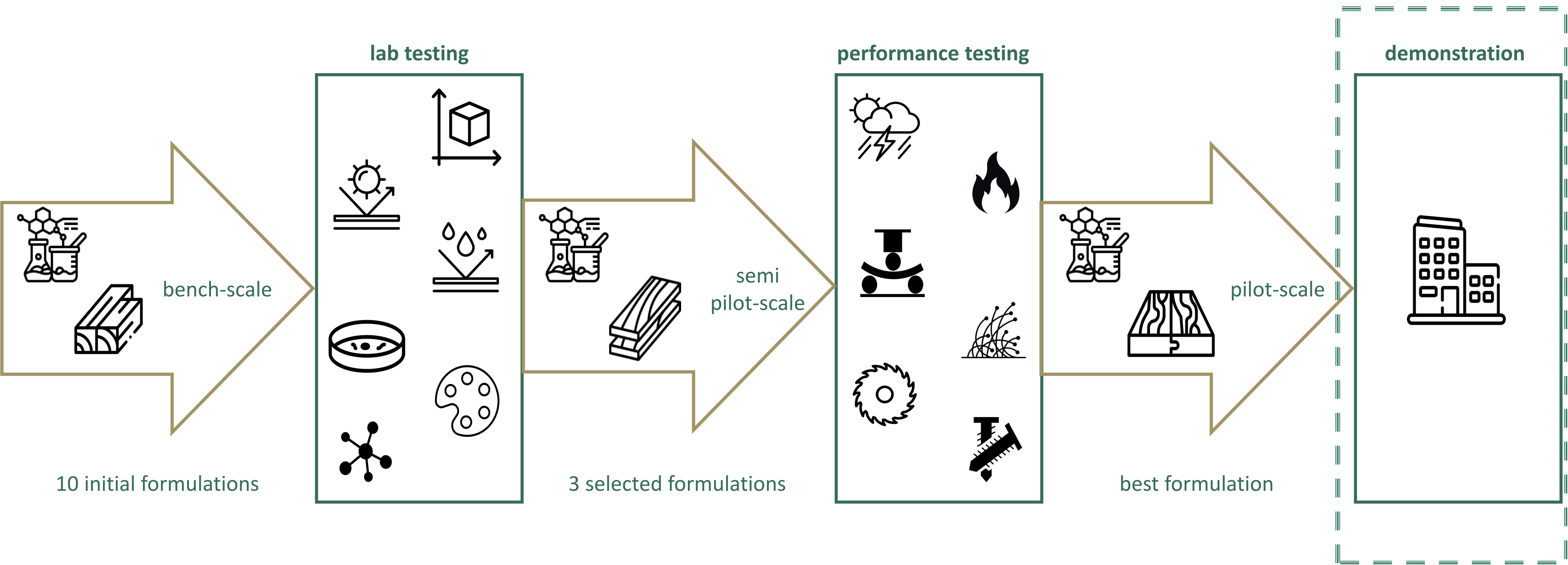
Due to brittleness (especially beech), pre-drilling is required to avoid splitting.

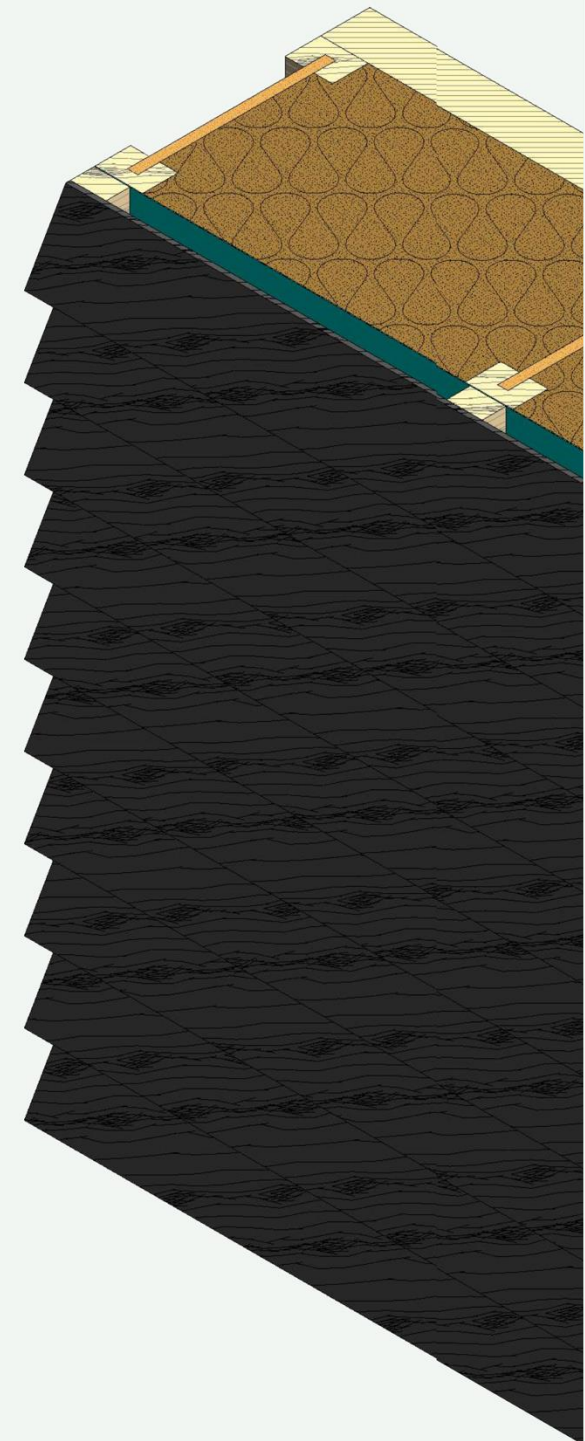
Alternative systems used for thermally modified wood façades may also be suitable.



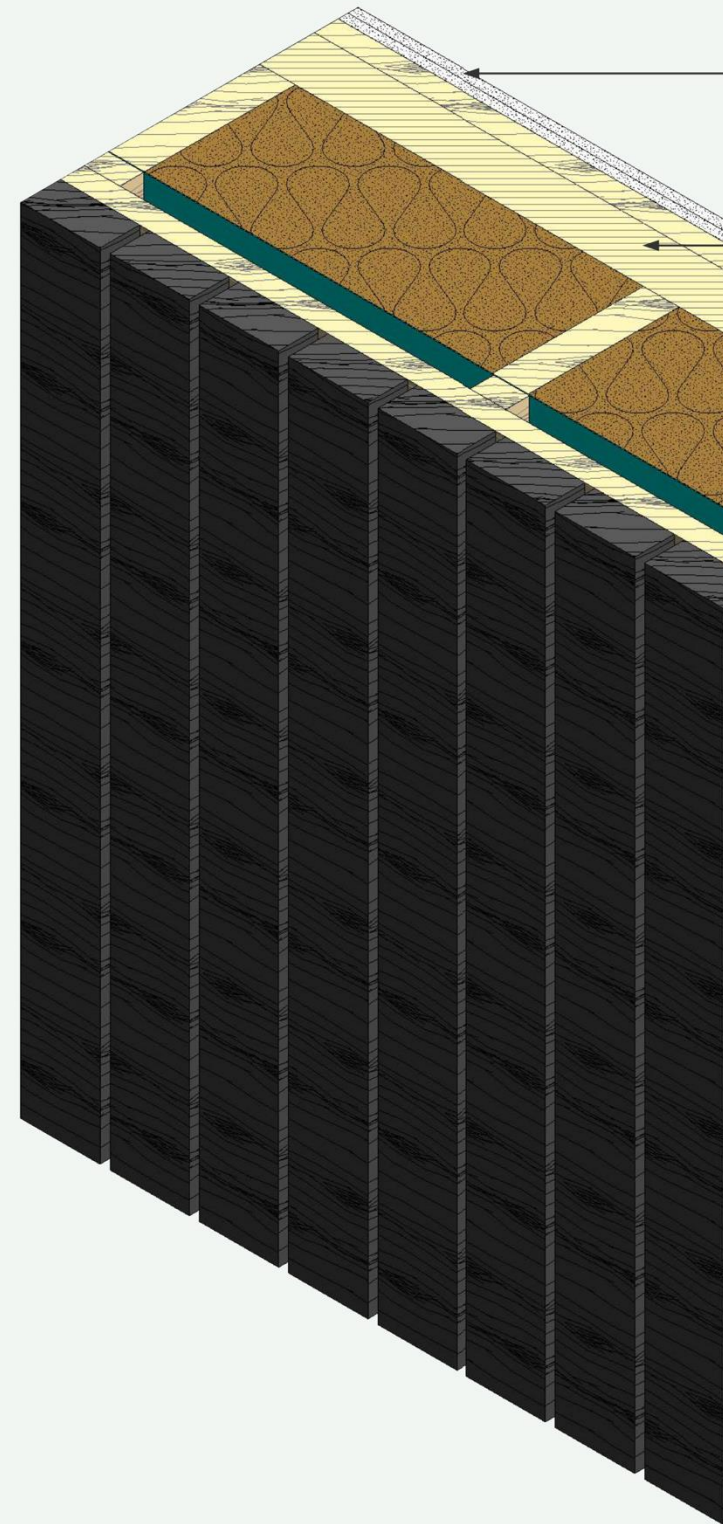


Schema of the workflow

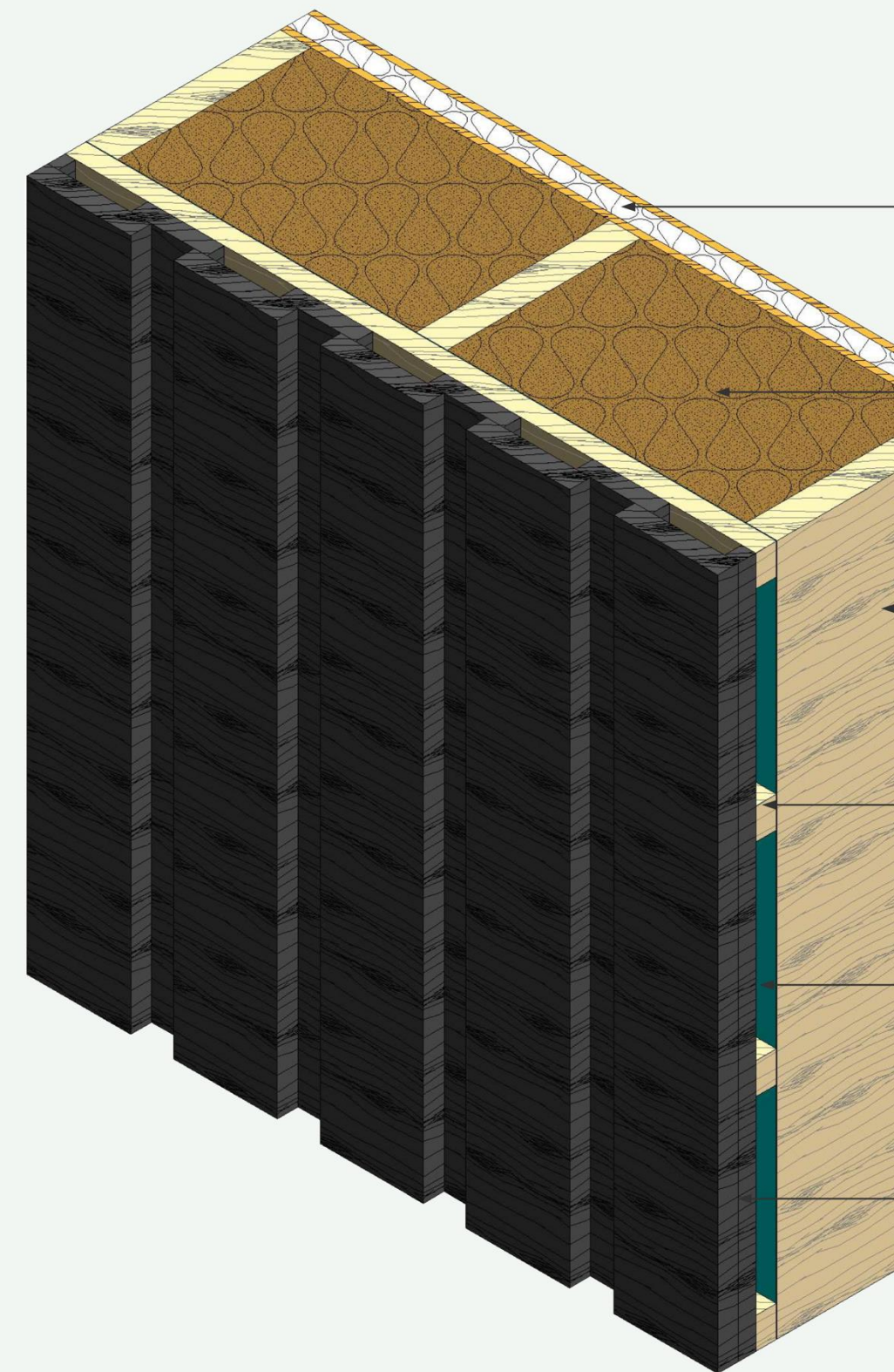




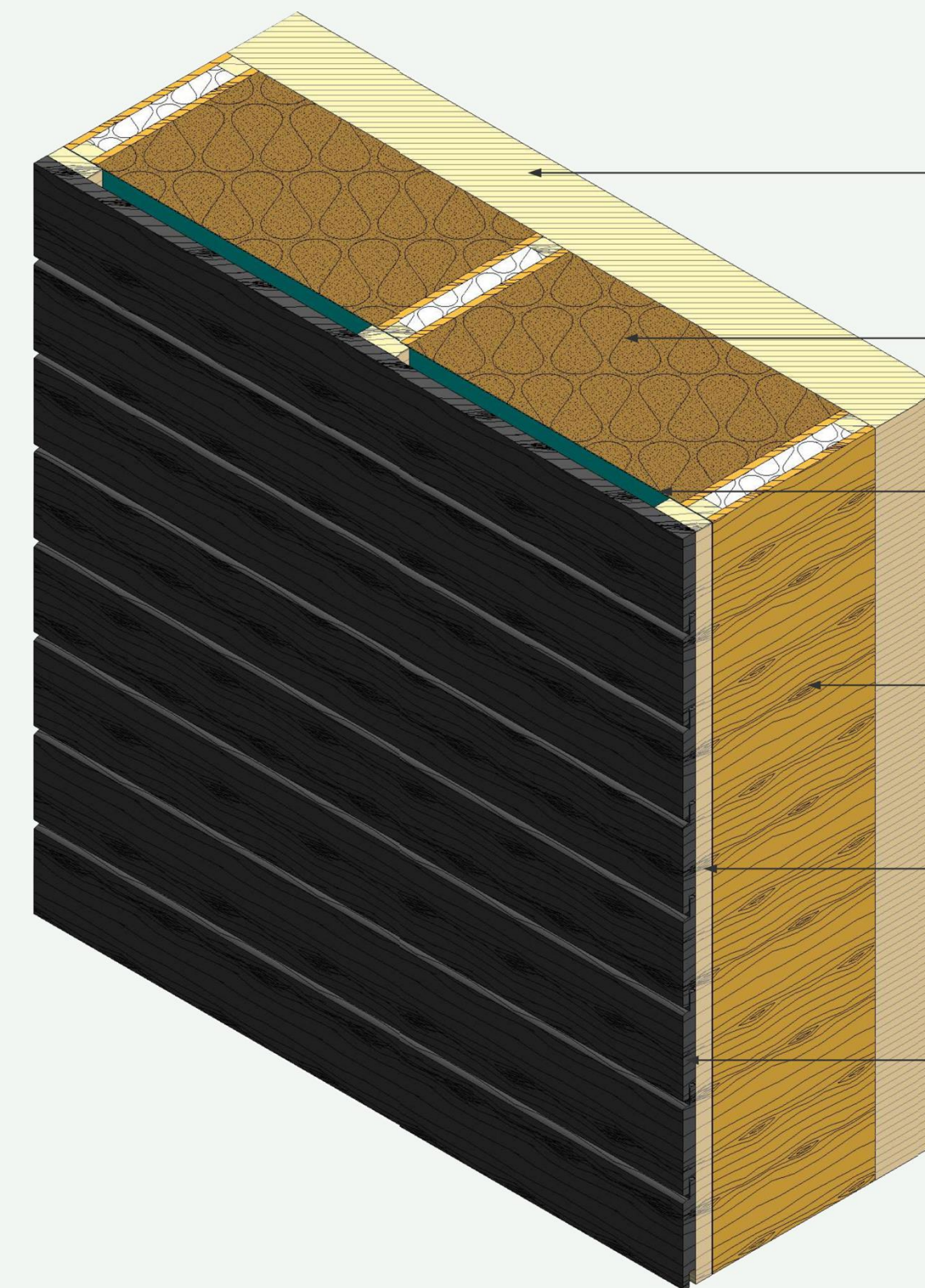
FPBO-modified wood
2C PUR adhesive



FPBO-modified wood
2C PUR adhesive



FPBO-modified wood
2C PUR adhesive
Plywood panel
MDF panel



FPBO-modified wood
2C PUR adhesive
Plywood panel
MDF panel
Foam

CLT poplar
Sheep wool insulation
WRB membrane
Sandwich panel
Spruce batten
Cladding (Radiata pine)



Demo site



Thank you!

 New Wave Project

newwave-horizon.eu

info@newwave-horizon.eu





Wood products, green resins and chemicals

a new wave of doing things



8:45-9:15 – Arrival

9:15-9:30 Welcome and keynote – Unlocking Biomass through Fast Pyrolysis – BTG

9:30-10:15 Sustainable Materials for the Modern Construction Sector

 **Engineered Wood Panels (Plywood and MDF) - FORESA Technologies**

 **Modified wood products for outdoor applications - FORECO and INNORENEW**

10:15-10:30 Coffee break

10:30 -11:00 Innovative green chemicals

 **Innovative green chemicals in polyurethanes – AEP Polymers**

 **Innovative green chemicals - Furanic derivatives - TFC**

11:00-11:30 Open discussion and Q&A

End of On-line event

11:30 Visit to the demo structure and products showcase



Innovative green chemicals in polyurethanes

04/03/2026

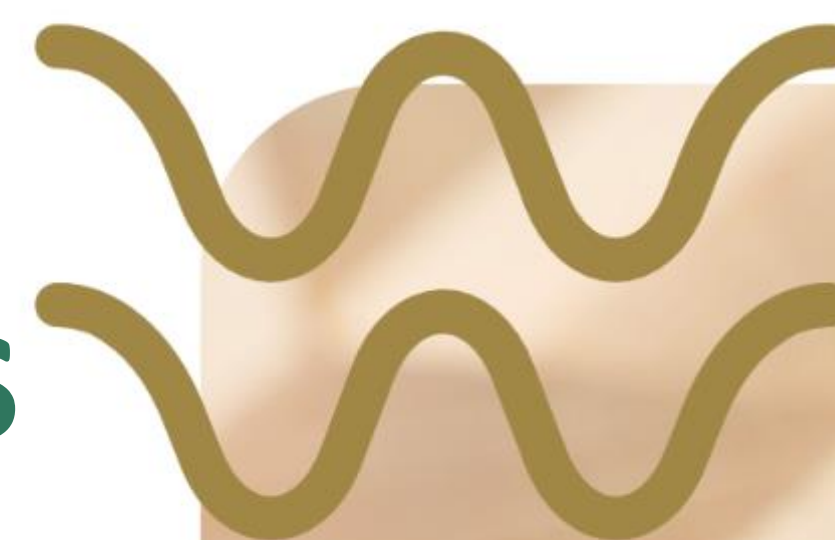
New Wave Project Final Conference @ Izola, Slovenia

Prepared by: David Contus



Funded by
the European Union

Grant Agreement No. 101058369. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or HADEA. Neither the European Union nor the granting authority can be held responsible for them



Outline



AEP Polymers

- About us
- Expertise
- Business model
- EU Funded Projects

NewWave

- Innovative green chemicals in PU applications
- Approach and main activities
- Demonstration products: key results
- Challenges

AEP Polymers



- Founded in 2013
- Based in Area Science Park (Trieste, Italy)
- Focused on industrial R&D
- Development of novel bio-based chemical building blocks and formulations



Main application sectors:

- Polyurethane **rigid foams** (e.g. thermal insulation for energy efficient buildings)
- Polyurethane **flexible foams**
- **CASE** (Coatings, Adhesives, Sealants & Elastomers)
- Fibre-reinforced **composites** (construction, automotive)
- **Thermoplastics**

Expertise

Our expertise is a blend of **organic chemistry** and **polymer science**

Two main type of activities:

1. Development of **new bio-based polymers** and their validation against commercial benchmarks
2. **Usability assessment** of bio-based products (lignin, proteins, fractions from biorefinery operations, etc.)

No production & commercialization: our products are recipes & knowledge



Valorisation of bio-renewable sources:

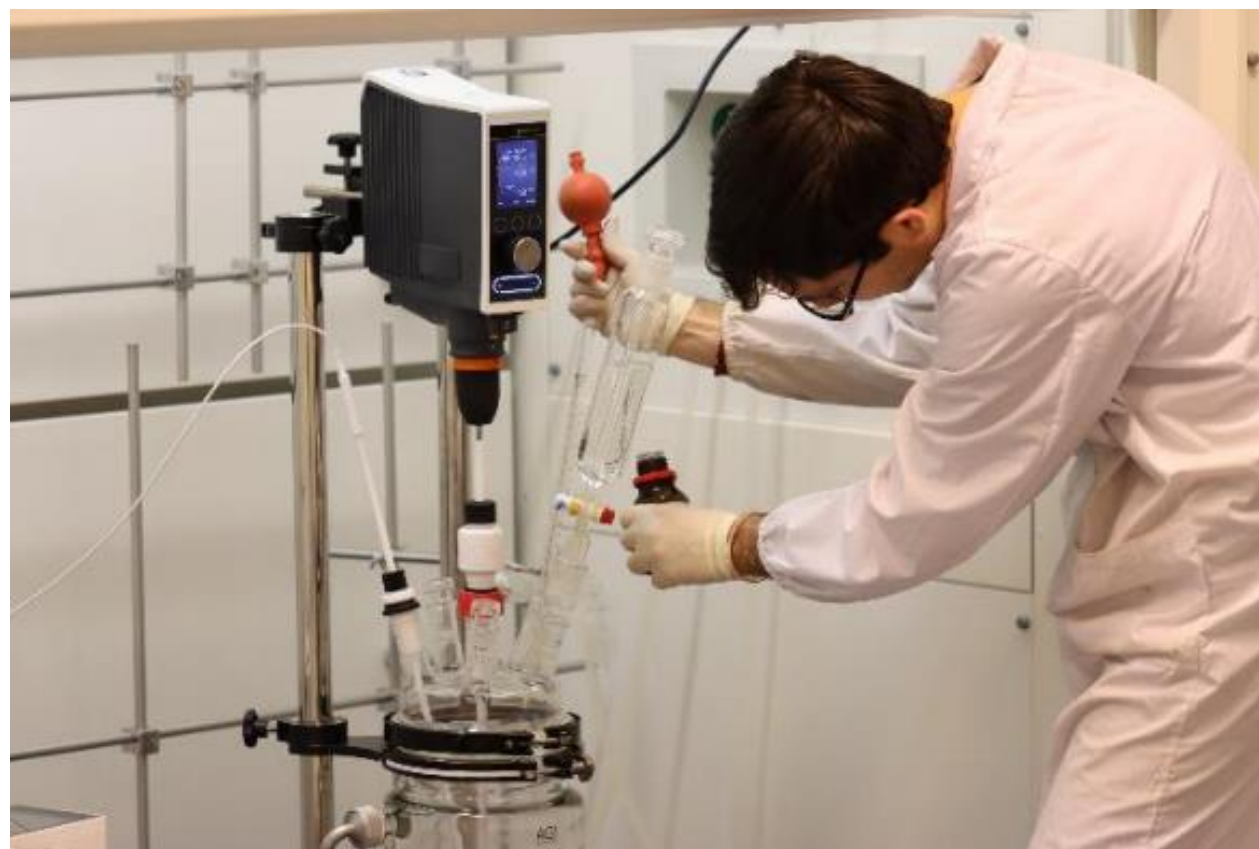
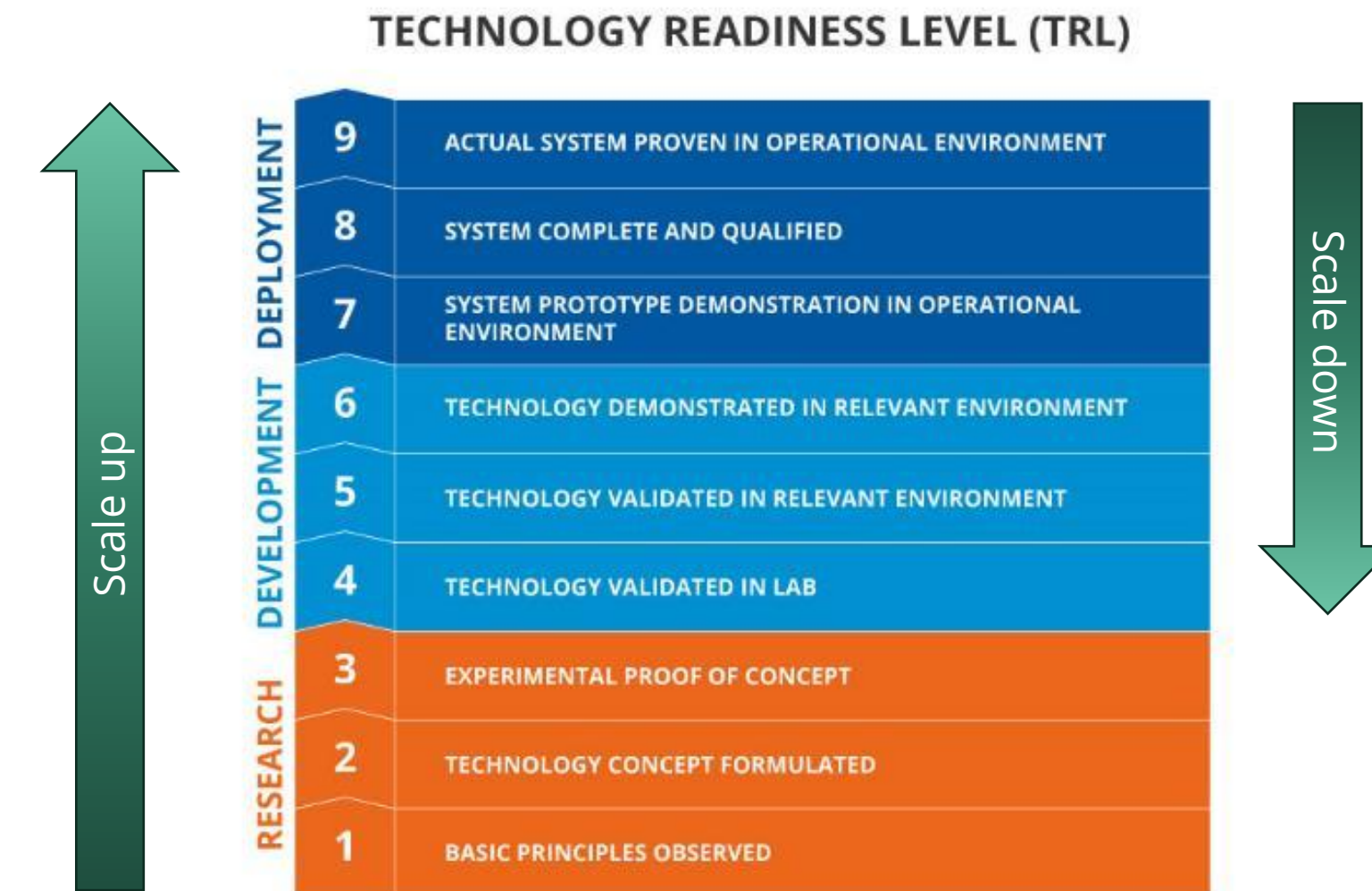
- CNSL (Cashew Nutshell Liquid)
- Lignin and lignin derivatives
- Plant derived oils



Laboratories

TRL=4-5

- “Advanced” laboratory scale
- Samples / prototypes
- Representative of specific applications



Two laboratories equipped for:

- Chemical syntheses
- Formulation and preparation of samples
- Chemical, thermal, mechanical characterization
- Processing of thermoplastics

Revenue streams

Consulting

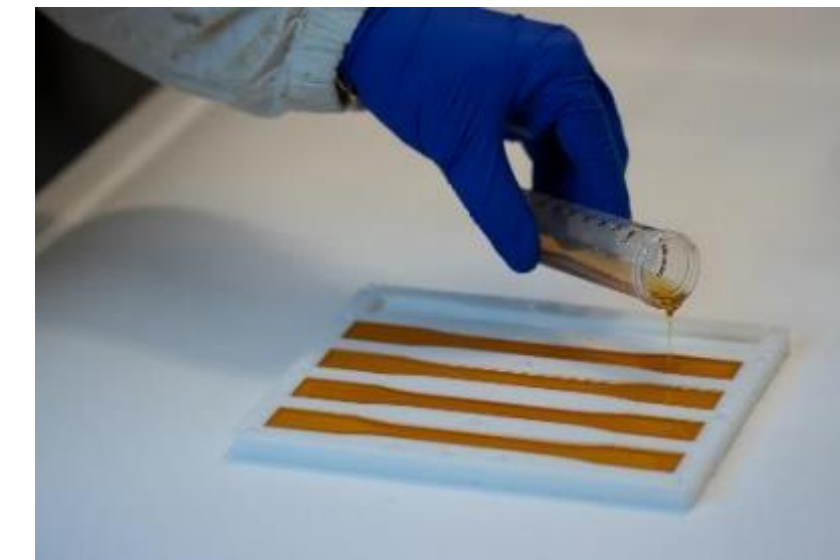
- Short-medium term commitment
- Narrower definition of work

Master Service Agreement

- Broad developmental work
- Longer term commitment
- Adaptive work plan
- Priority dedicated R&D time
- Assistance on regulations (EU-REACH, TSCA, etc.), preparation of TDS, technical support to sales force

Funded R&D projects

- Mainly EU programs
- Useful to explore new raw materials and new collaborations



EU projects & industrial applications



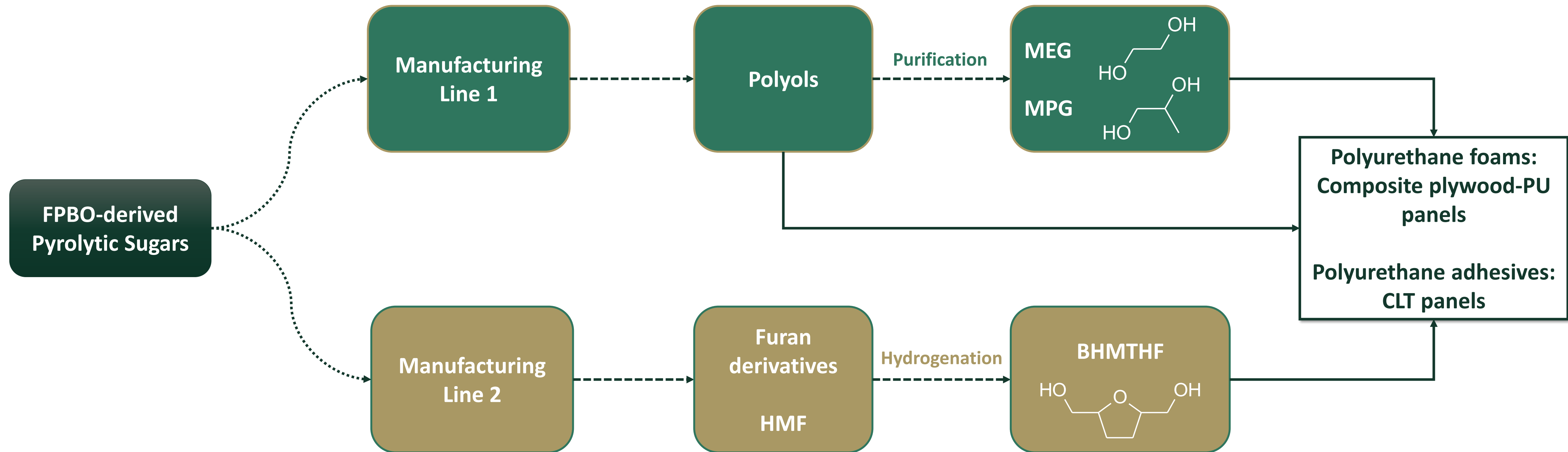
Feedstock	Material used	Projects	Applications
Lignocellulosic bio-mass	Lignin and derivatives	SmartLi VAMOS LIGNICOAT	Rigid and flexible PU foams PU and epoxy adhesives Epoxy coatings
	Fast pyrolysis oil (fractions)	NewWave	Rigid PU foams 1K and 2K adhesives
	Hemicellulose derivatives (furfural, 5-HMF)	BioSPRINT	Polyols from furanic monomers Rigid PU foams
	Sugars derivatives (isosorbide, succinic acid)	Viprisca FRACTION	NIPU coatings UV curable coatings PU rigid foams and adhesives
Plant seeds	Fatty acid oils	ReInvent BIOMAT	Rigid and flexible PU foams for automotive and construction
MSW (organic fraction)	Post-hydrolysis solid	VAMOS	Epoxy grouts for construction
Miscellanea	Multiple sources	R-LightBioCom EOLIAN	Vitrimer resins and epoxy formulations for composites



A stylized gold wave icon consisting of two stacked, rounded, wavy lines.

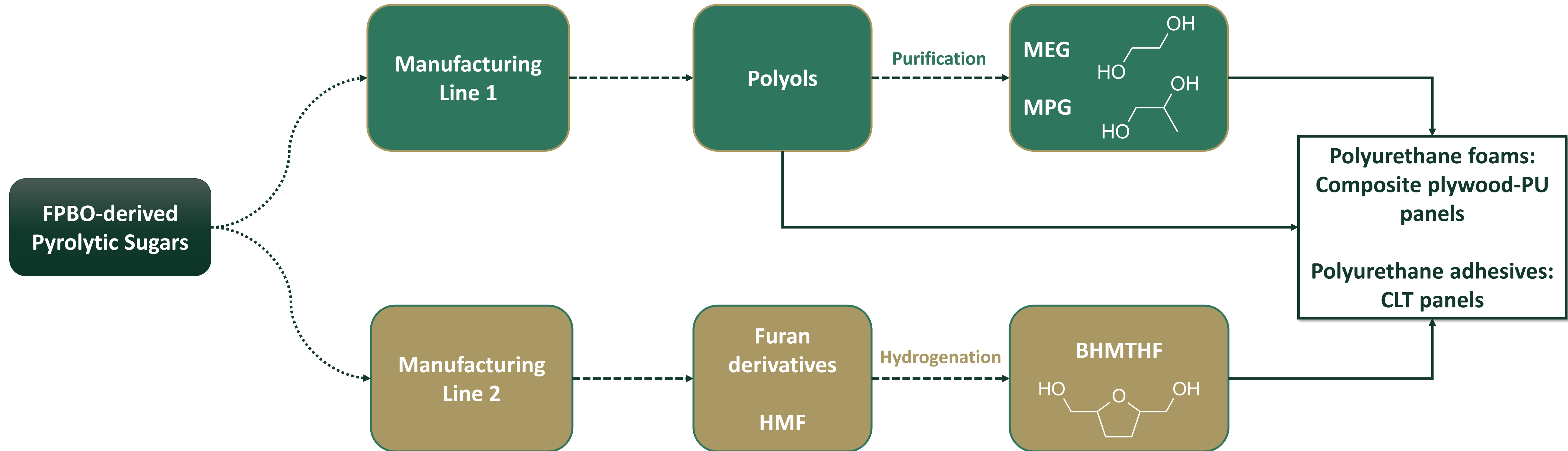
NewWave

Innovative green chemicals in PU applications



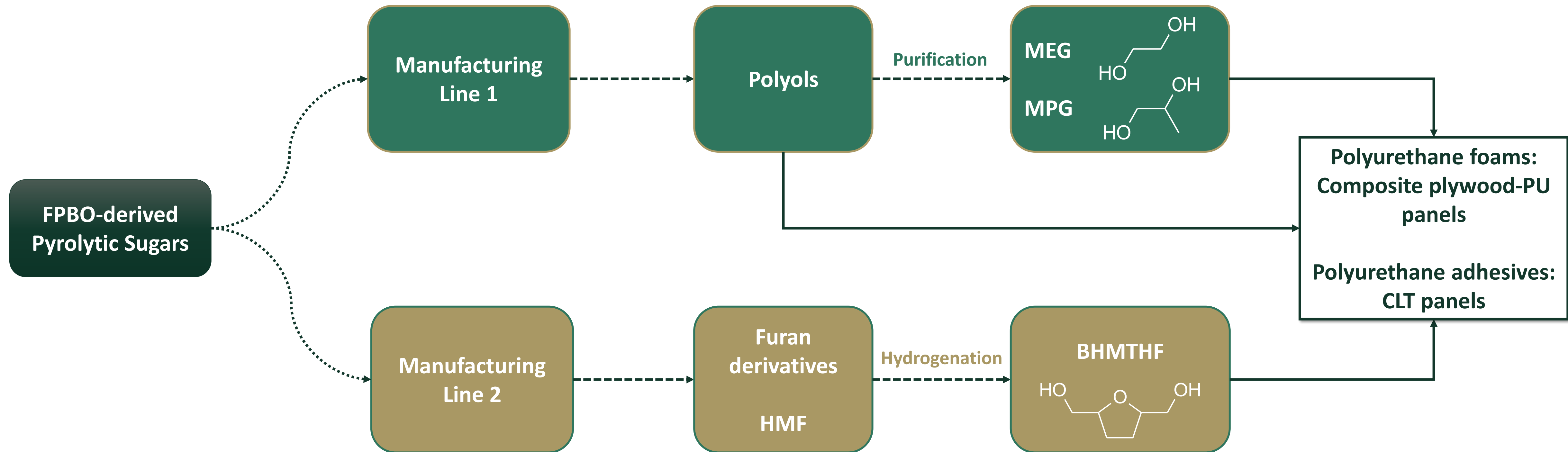
- **Target:** construction industry (wood) → production of **CLT** and **composite PU-wood** panels

Innovative green chemicals in PU applications



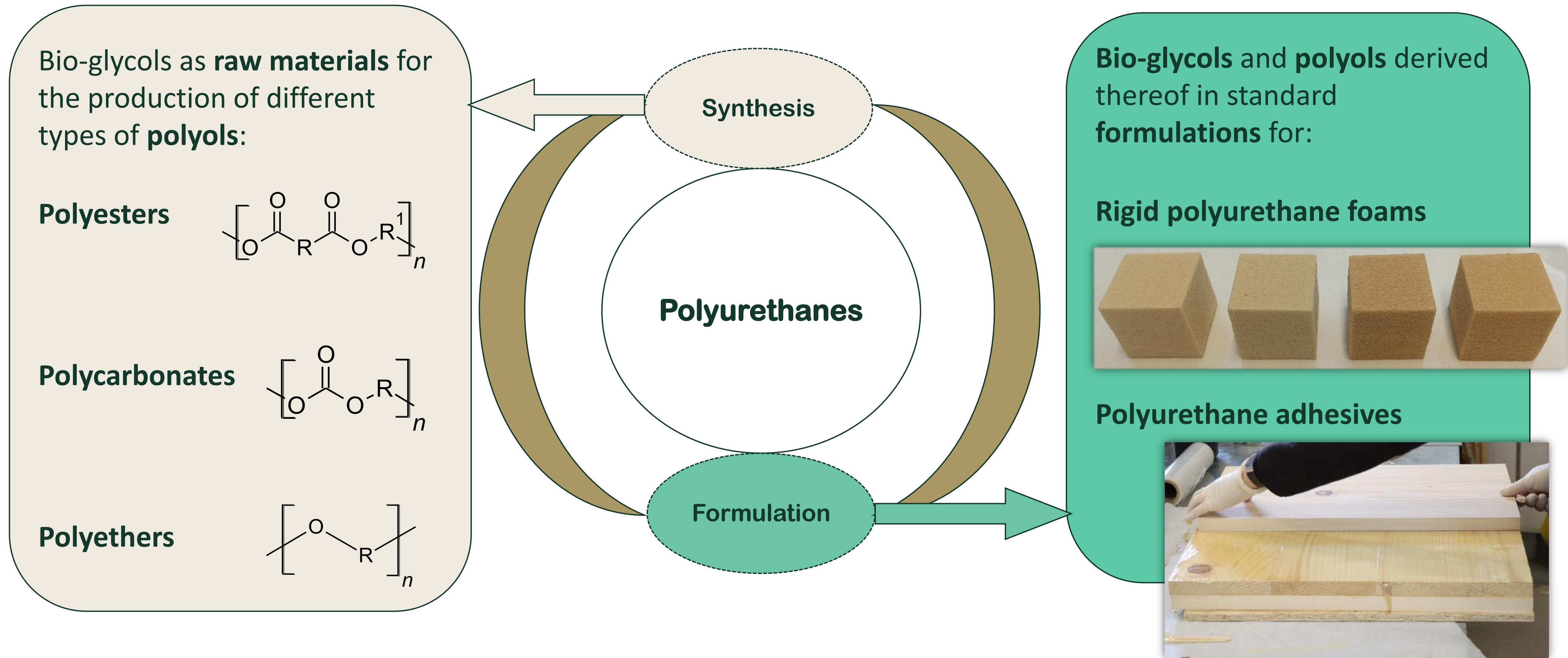
- **Target:** construction industry (wood) → production of **CLT** and **composite PU-wood** panels
- **Glycols:** important **building blocks** in **polyurethane** chemistry

Innovative green chemicals in PU applications

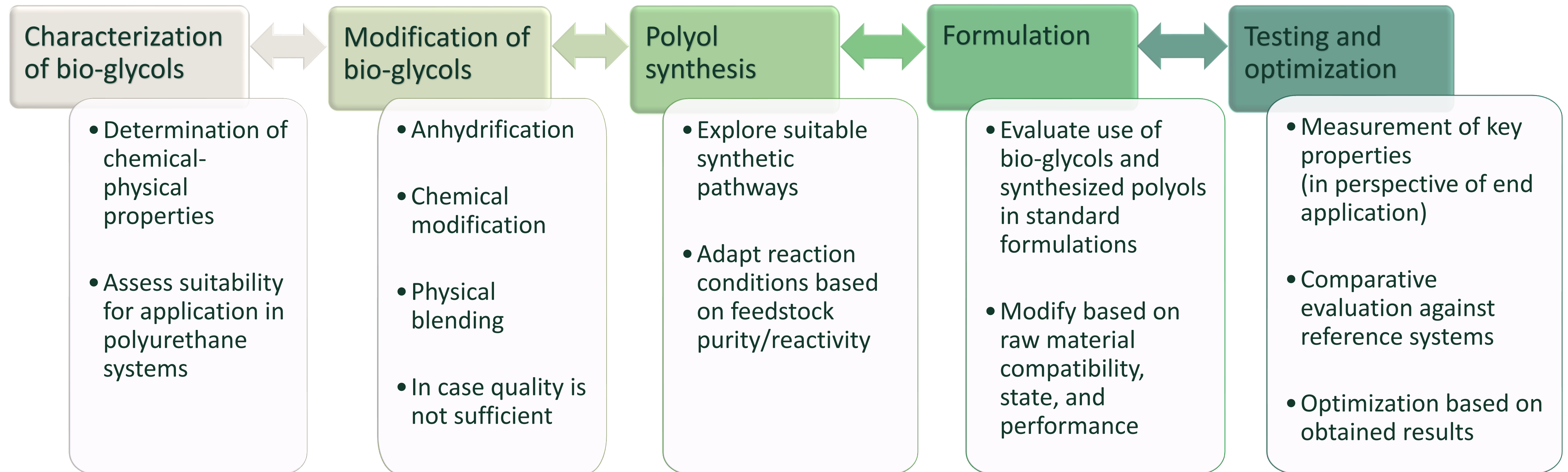


- **Target:** construction industry (wood) → production of **CLT** and **composite PU-wood** panels
- **Glycols:** important **building blocks** in **polyurethane** chemistry
- Use of **bio-based glycols** → impact the **sustainability** of both **raw materials for PU production** and **PU foams and adhesives** derived thereof

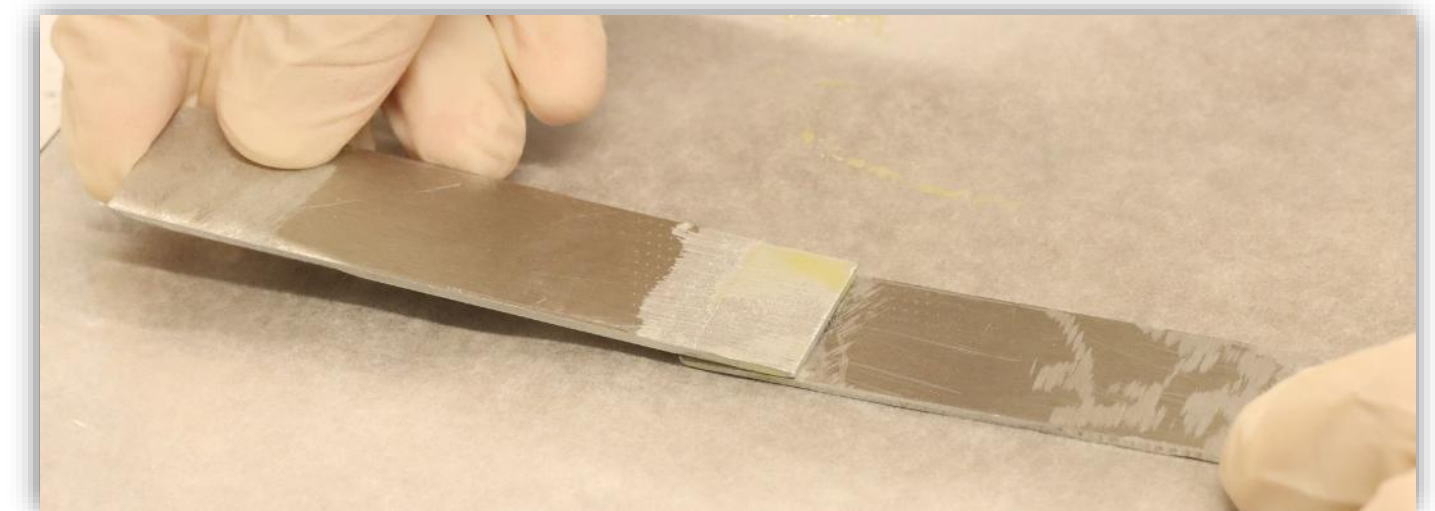
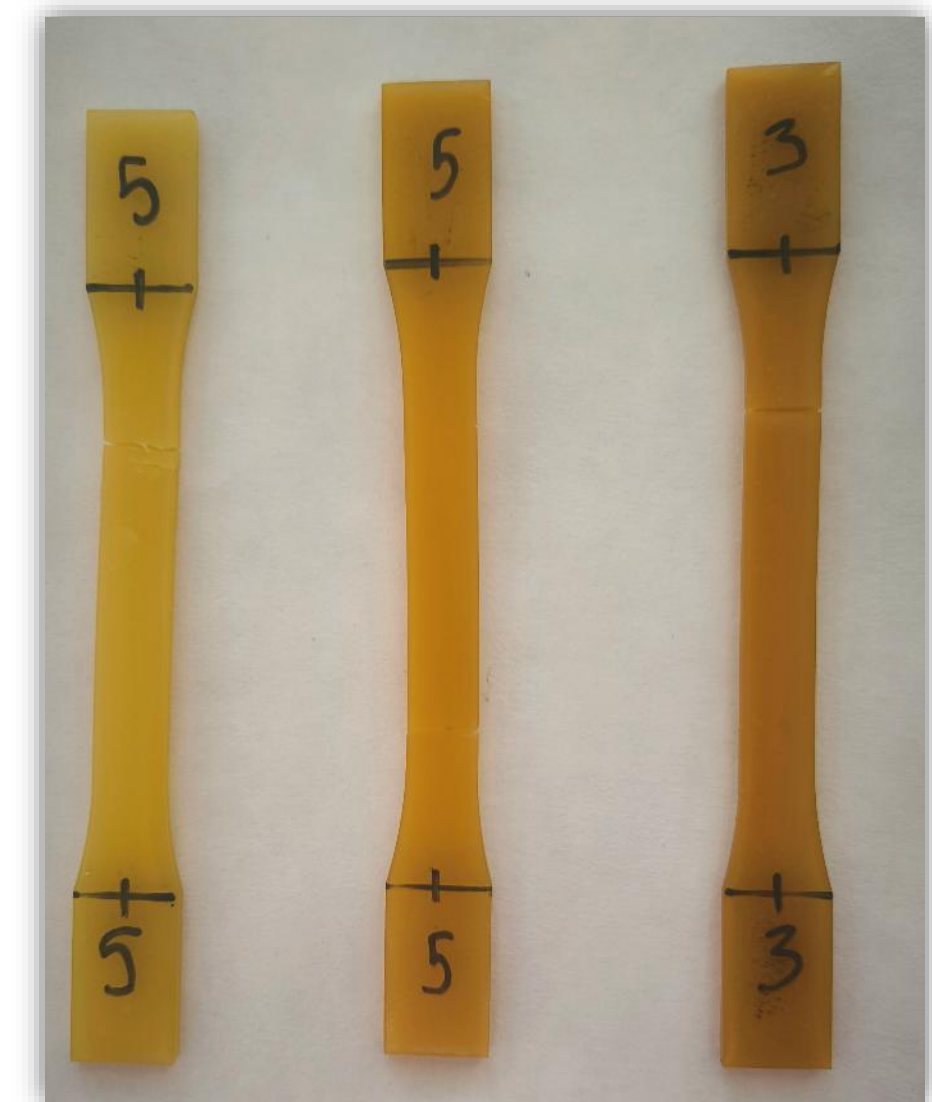
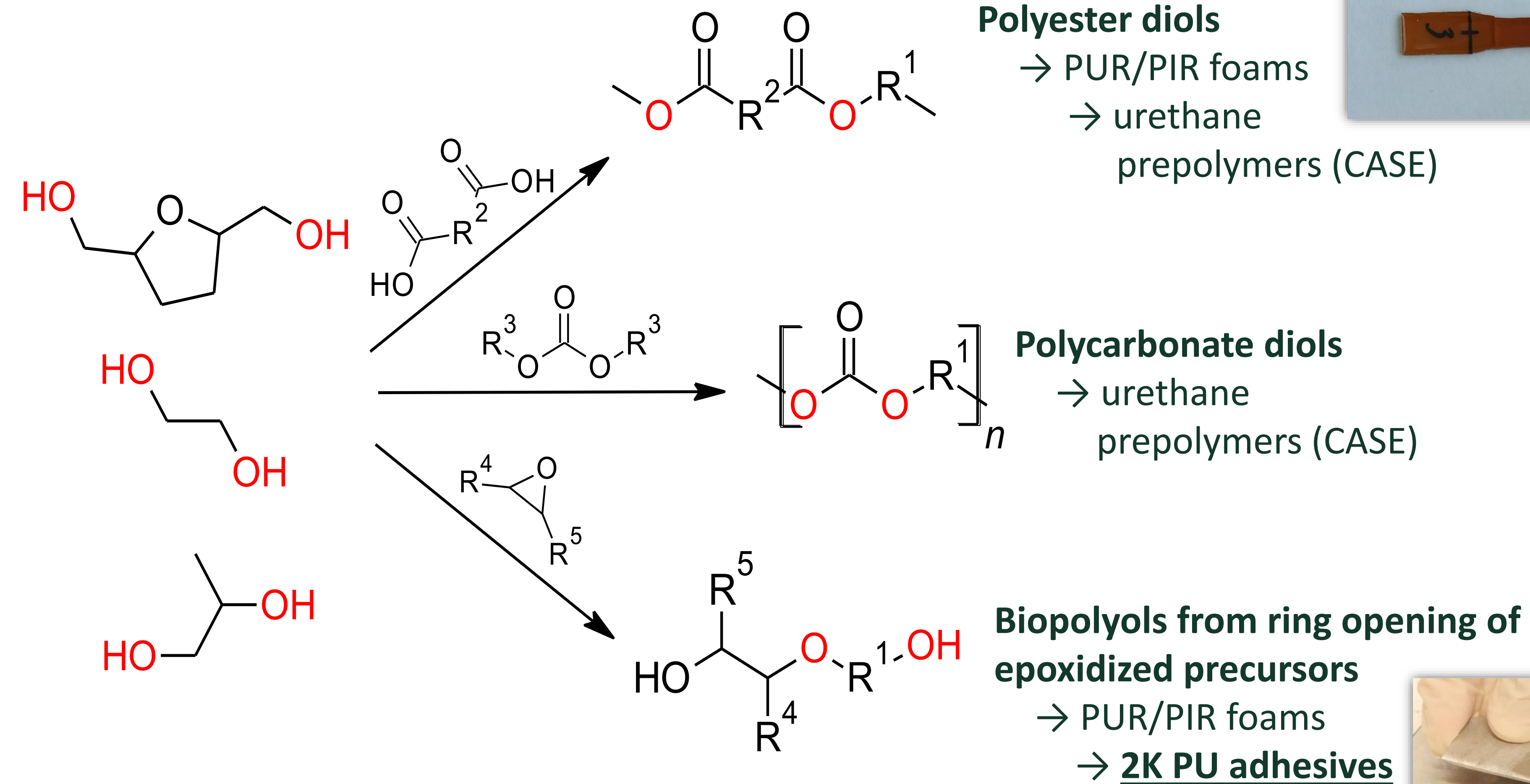
Innovative green chemicals in PU applications



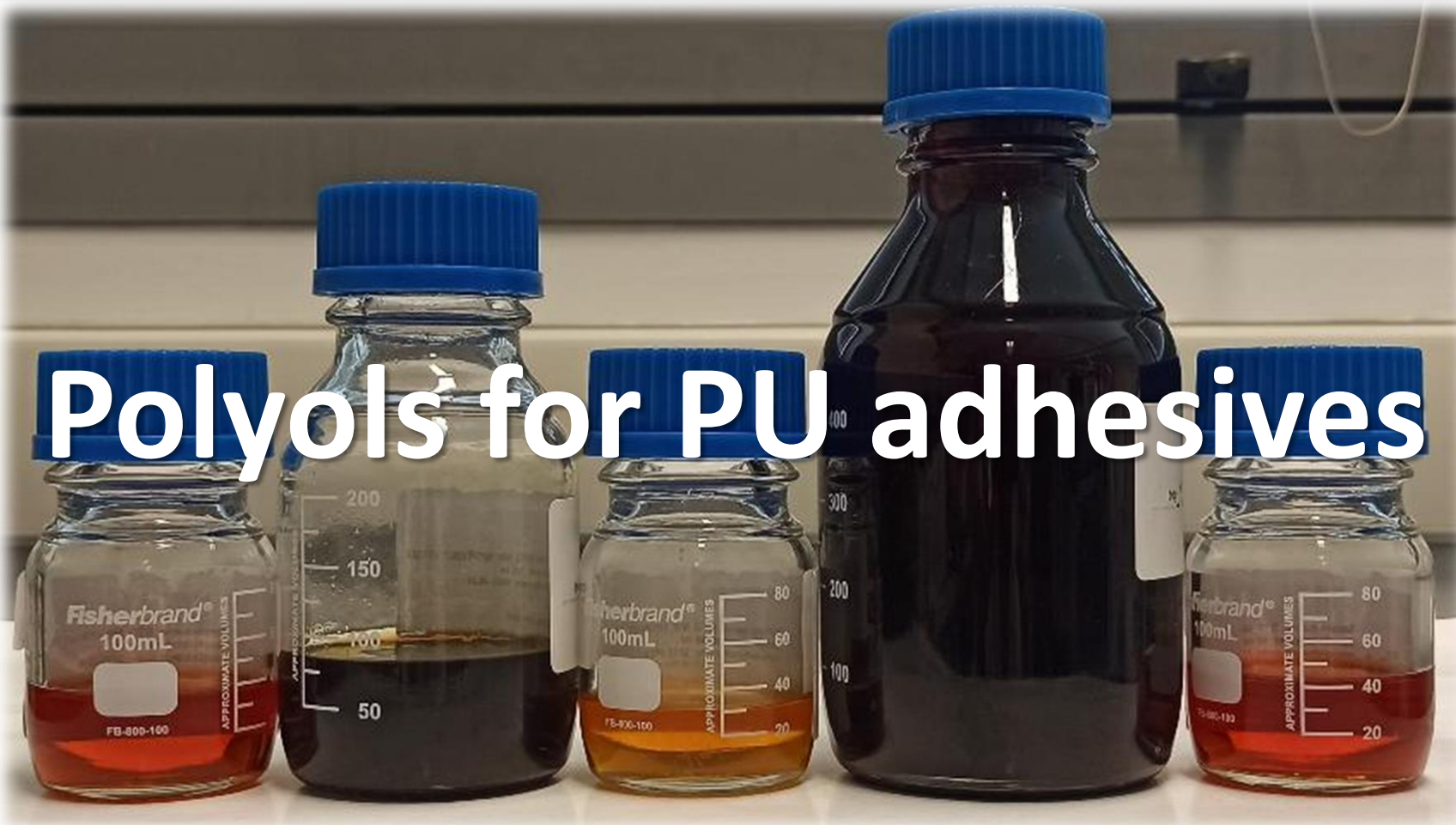
Approach and main activities



Synthetic pathways and suitable applications



PU adhesives for production of CLT panels: key results



Development of **several polyols** based on bio-glycols derived from pyrolytic sugars

Bio-glycol content of up to 32%



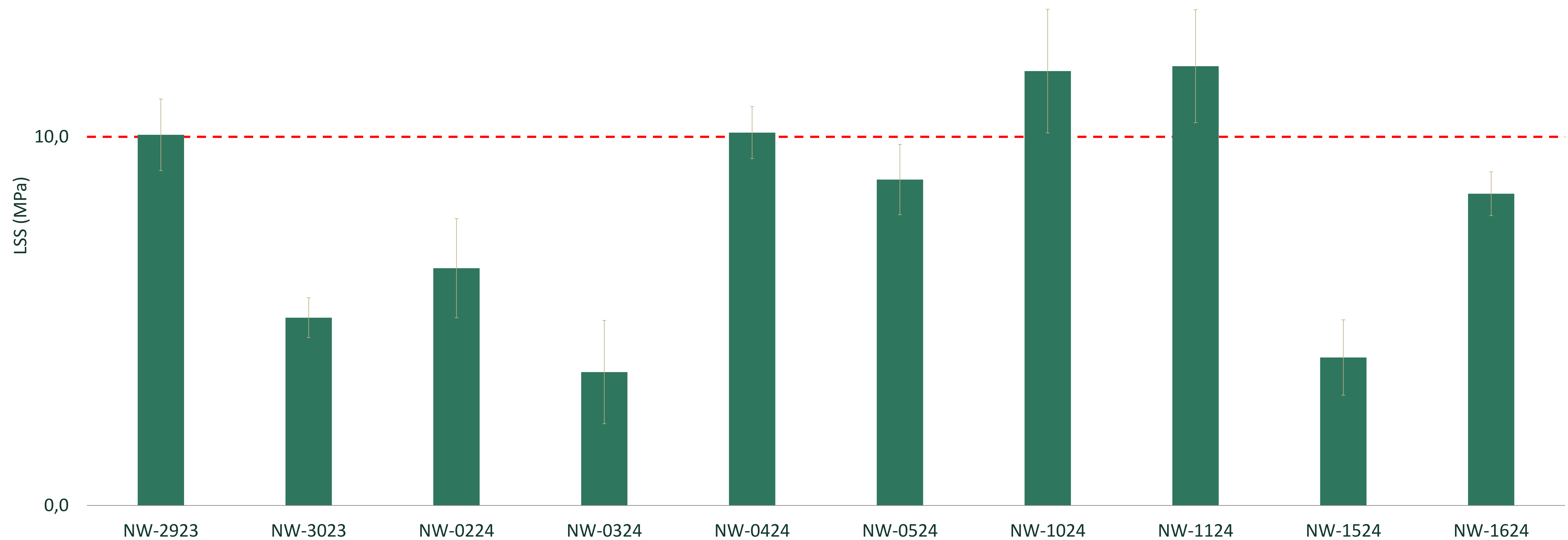
Developed bio-based polyols → **sole polyol component** of the formulation

Formulation of two systems that meet **D1** and **D2 durability class** requirements (according to EN 204/205)

PU adhesives for production of CLT panels: key results



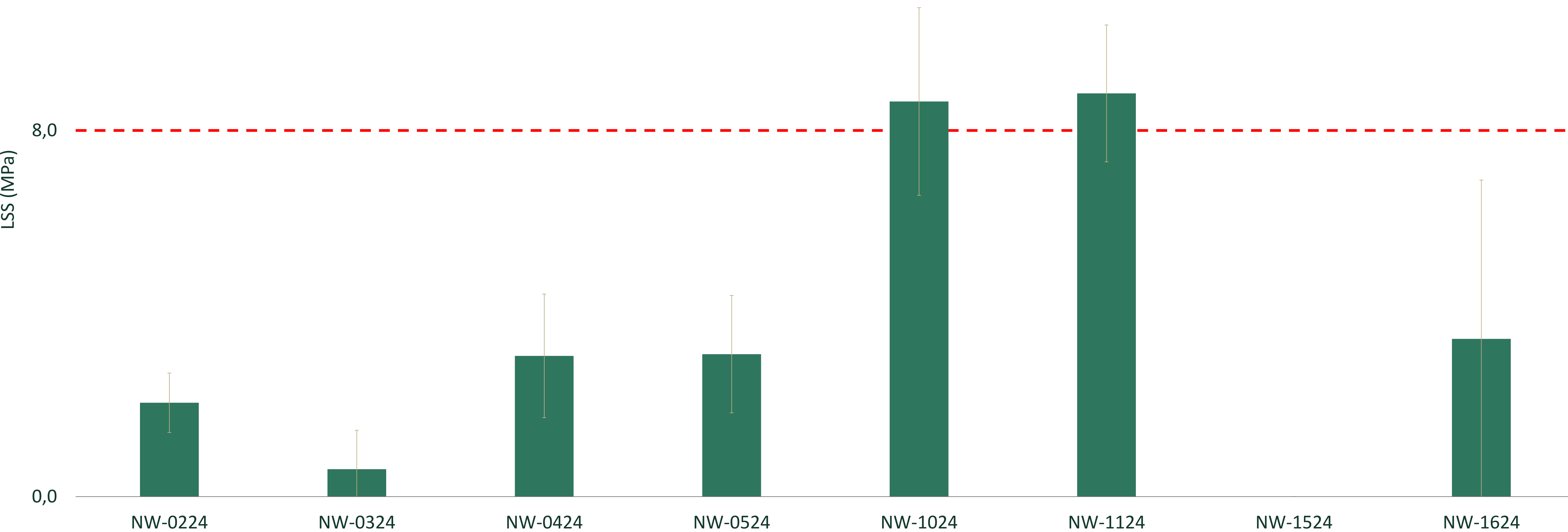
EN204/205 shear test on beech wood (*Fagus sylvatica*) for D1 durability class



PU adhesives for production of CLT panels: key results



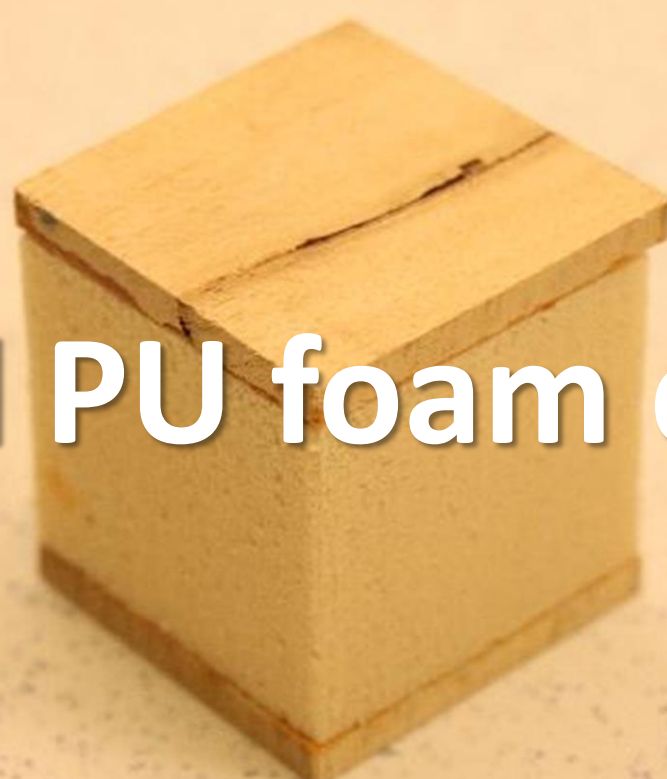
EN204/205 shear test on beech wood (*Fagus sylvatica*) for D2 durability class



Production of demonstration material: composite plywood-PU panels



Composite plywood-PU panels: key results



Rigid PU foam core

Partial replacement of **petrol-based** reference polyol with a **bio-based polyol** derived from pyrolytic sugar

Optimization of reactivity parameters to match requirements for production of composite panels

Properties comparable to the reference

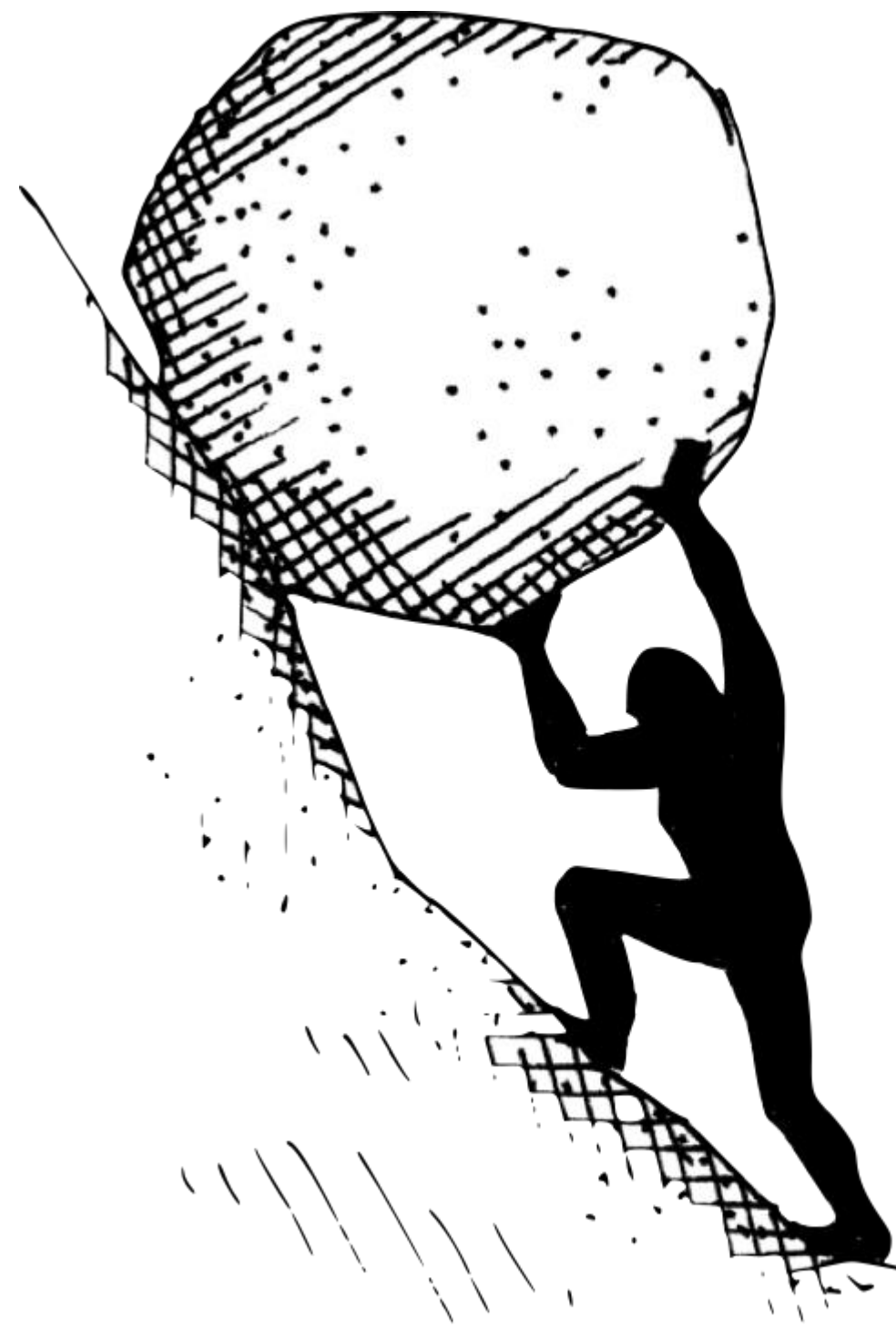


Composite
plywood-PU panels

Production of **15** panels in total, **8** of which used for assembly of **mock-up** (covering a 2m² surface)

Mechanical, thermal and acoustic performance comparable to reference panels made with petrol-based raw materials

Challenges



1

Purity and complex composition of biomass-derived raw materials

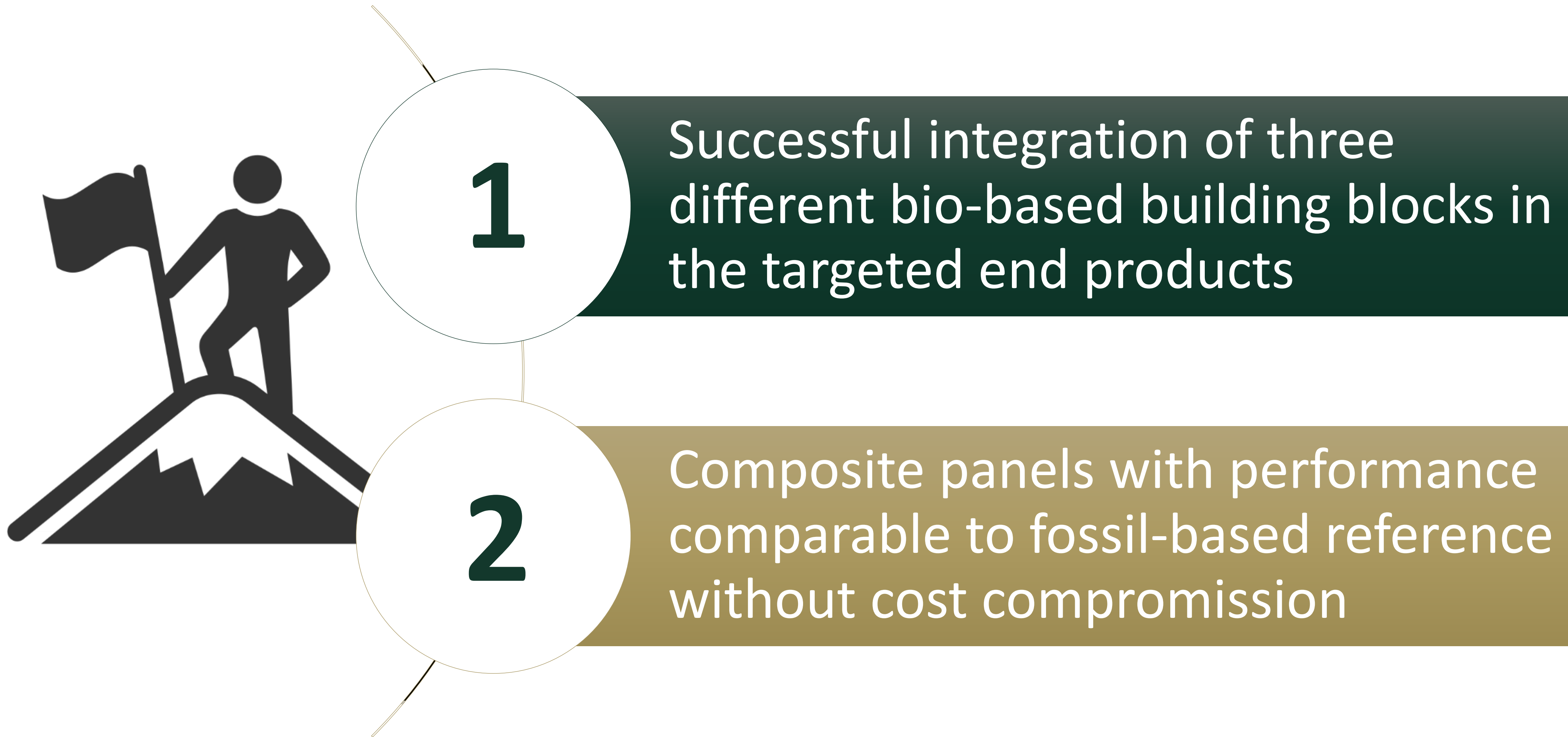
2

Additional purification steps to meet quality requirements

3

Residual smell of biomass-derived raw materials

Achievements



Thank you!

 New Wave Project

newwave-horizon.eu

info@newwave-horizon.eu





Innovative green chemicals

Furanic derivatives

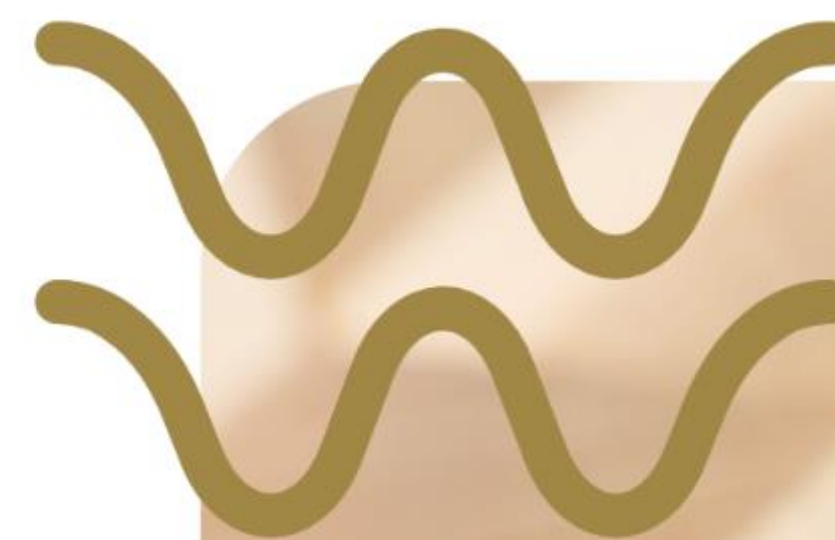
Date: March 4th, 2026

Prepared by: Rik De Clercq, Toon Bouwen



Funded by
the European Union

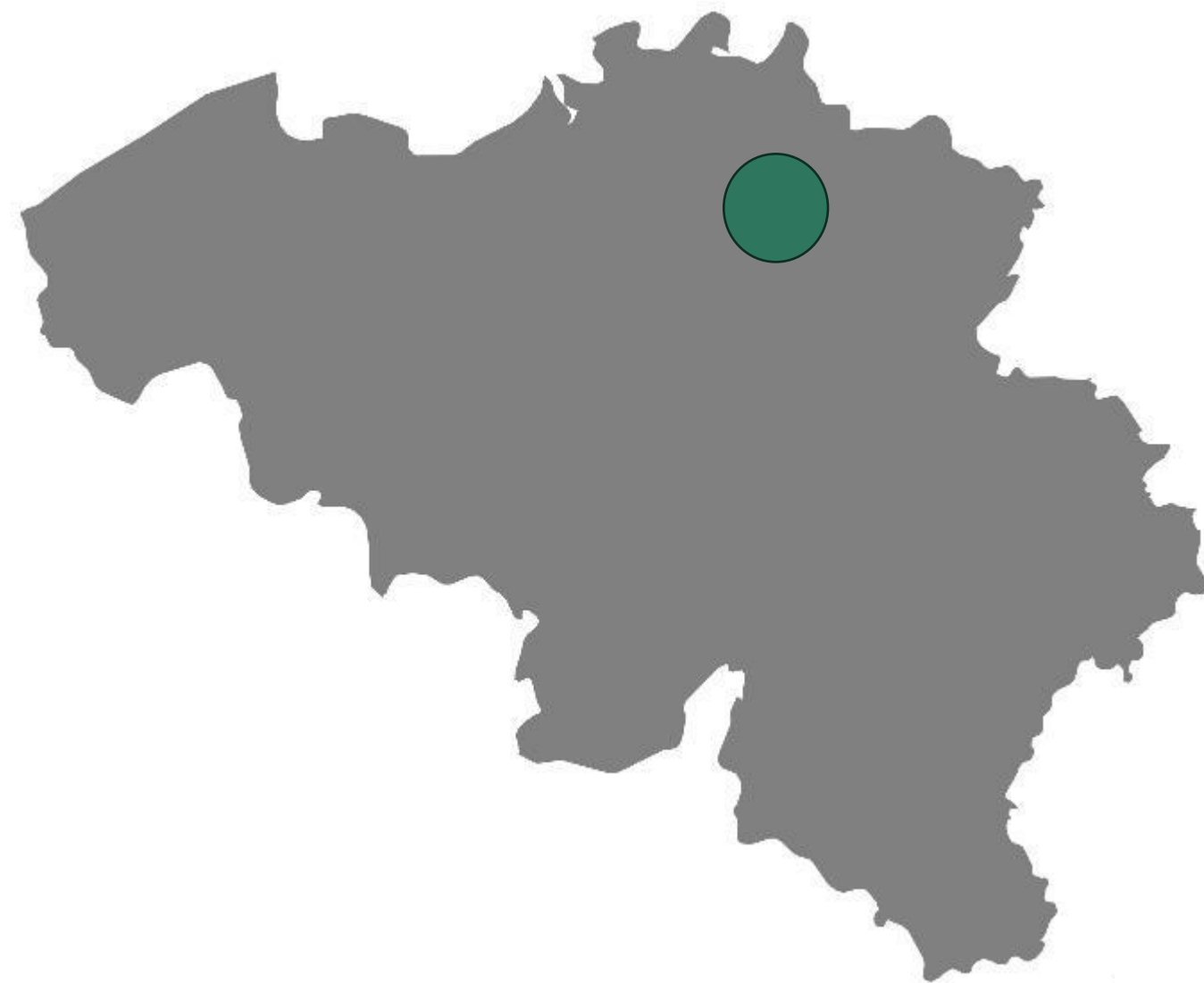
Grant Agreement No. 101058369. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or HADEA. Neither the European Union nor the granting authority can be held responsible for them



TransFurans Chemicals:

Biobased chemical manufacturer

- Active since 1972
- > 40 000 MT/Y capacity
- 50 FTE



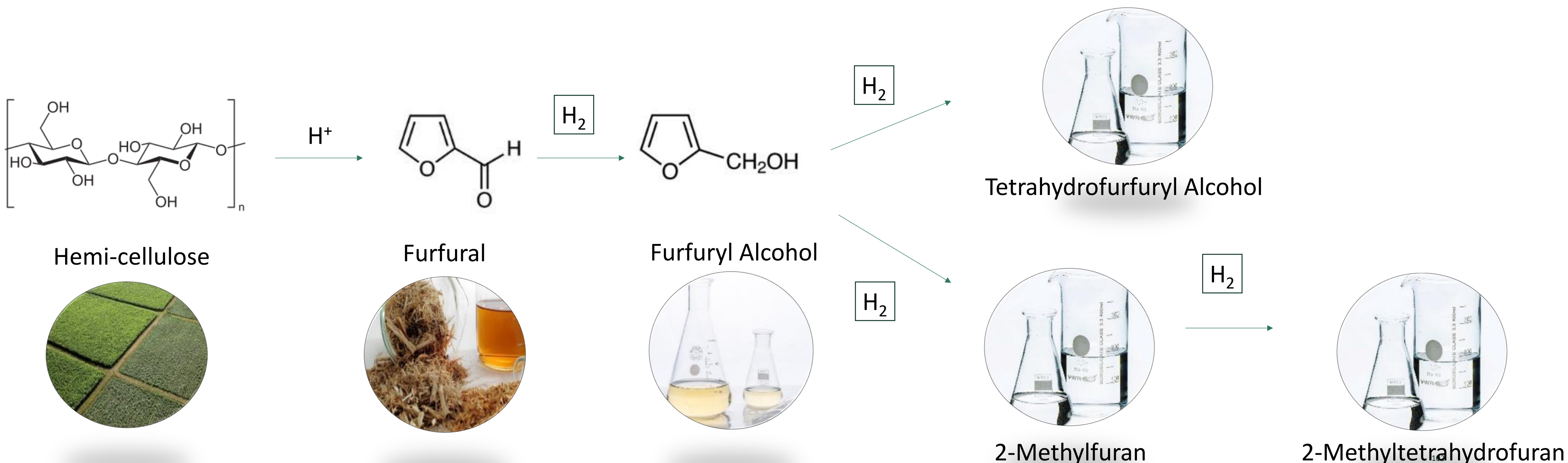
EN ISO 9001: 2015
Quality Management System

EN ISO 14001 : 2015
Environmental Management System

CORE: Furfural based chemistry

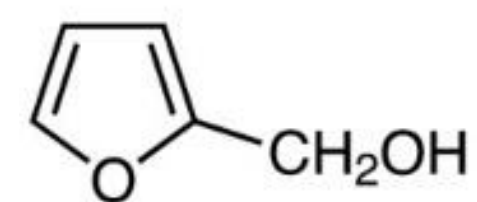
We turn agricultural crop waste into bio-based chemicals and polymers

- 100% of the carbon in furfuryl alcohol & derivatives is bio-based. More than 97% of our raw materials is bio-based and by preference made from agricultural waste streams.

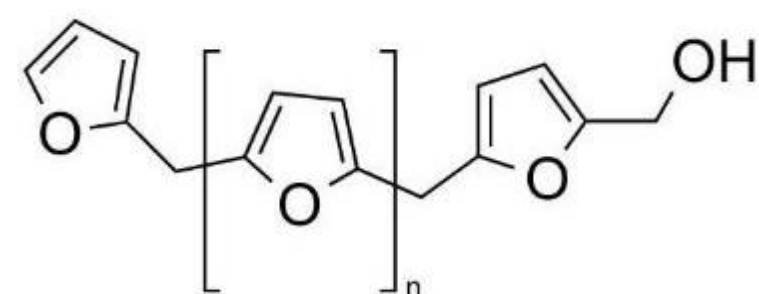


Furfuryl Alcohol resins

Experts in PFA - in close collaboration with customers



Furfuryl Alcohol



Furfuryl Alcohol resin systems



FUROSET

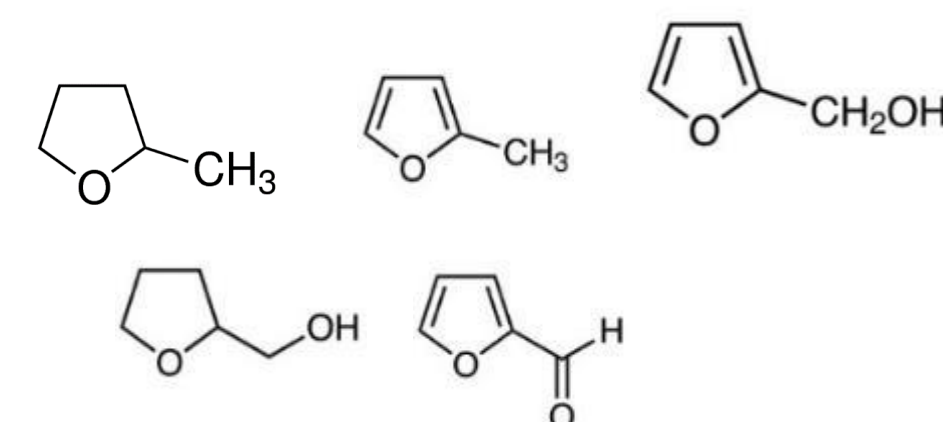
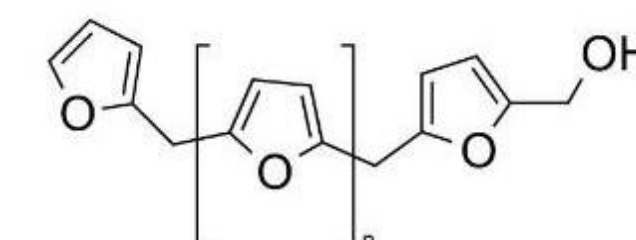
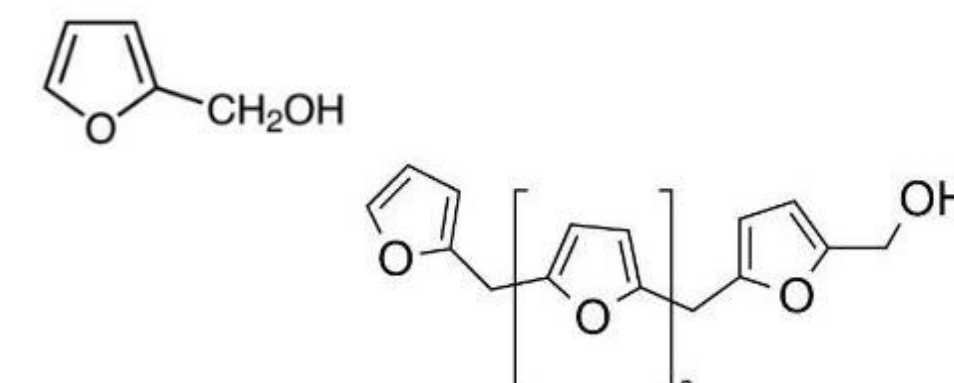
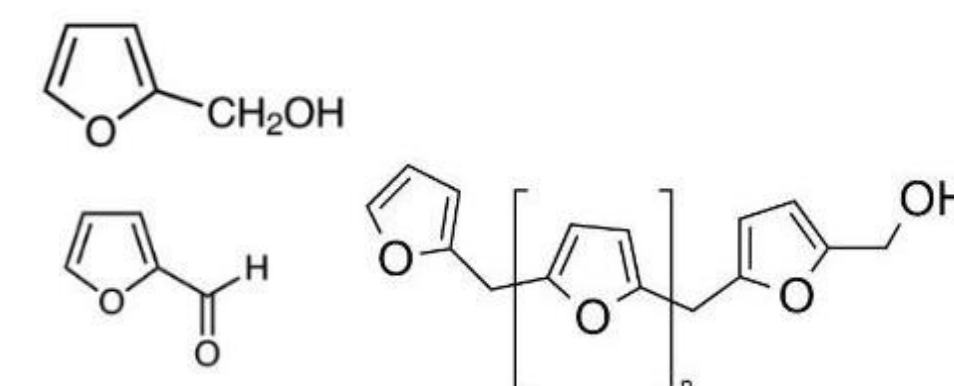
FUROLITE

BIOREZ™



LEADING SUPPLIER OF FURFURAL DERIVATIVES AND POLYMERS USED ACROSS MULTIPLE INDUSTRIES

HEAVY INDUSTRIES	• Foundry • Refractory • Anti-corrosion 
BUILDING & CONSTRUCTION	• Insulation • High Pressure Laminates • Modified wood 
AEROSPACE, RAIL, PUBLIC TRANSPORT, AUTOMOTIVE	• Fire resistant composites • Biocomposites / NFRP 
PHARMA, COSMETICS AND FRAGRANCES	• Solvents & Raw materials for API production • Raw materials for cosmetic ingredients and fragrances 



R&D collaborations & possibilities



Wide variety of in-house possibilities

- Lab reactors (300 mL - 2 L - 20 L) - focus on gas & liquid phase hydrogenation
- Pilot reactor (1 300 L)
- Analytical equipment (Titrimetry, Chromatography, Distillation...)
- Application testing (Focused on resins & composite applications)



The NewWave logo, consisting of two stylized, overlapping wavy lines in a gold color.

NewWave

Manufacturing line for HMF and furan derivatives



Goal:

- Production of HMF (5-Hydroxymethylfurfural) as versatile renewable platform chemical
- **Chemical upgrading of HMF and other furan derivatives through hydrogenation and hydrogenolysis**

Fractionation of FPBO
to produce pyrolytic sugars



Analysis, optimization and lab-
scale production of HMF



Upscaling to bench-scale HMF
production

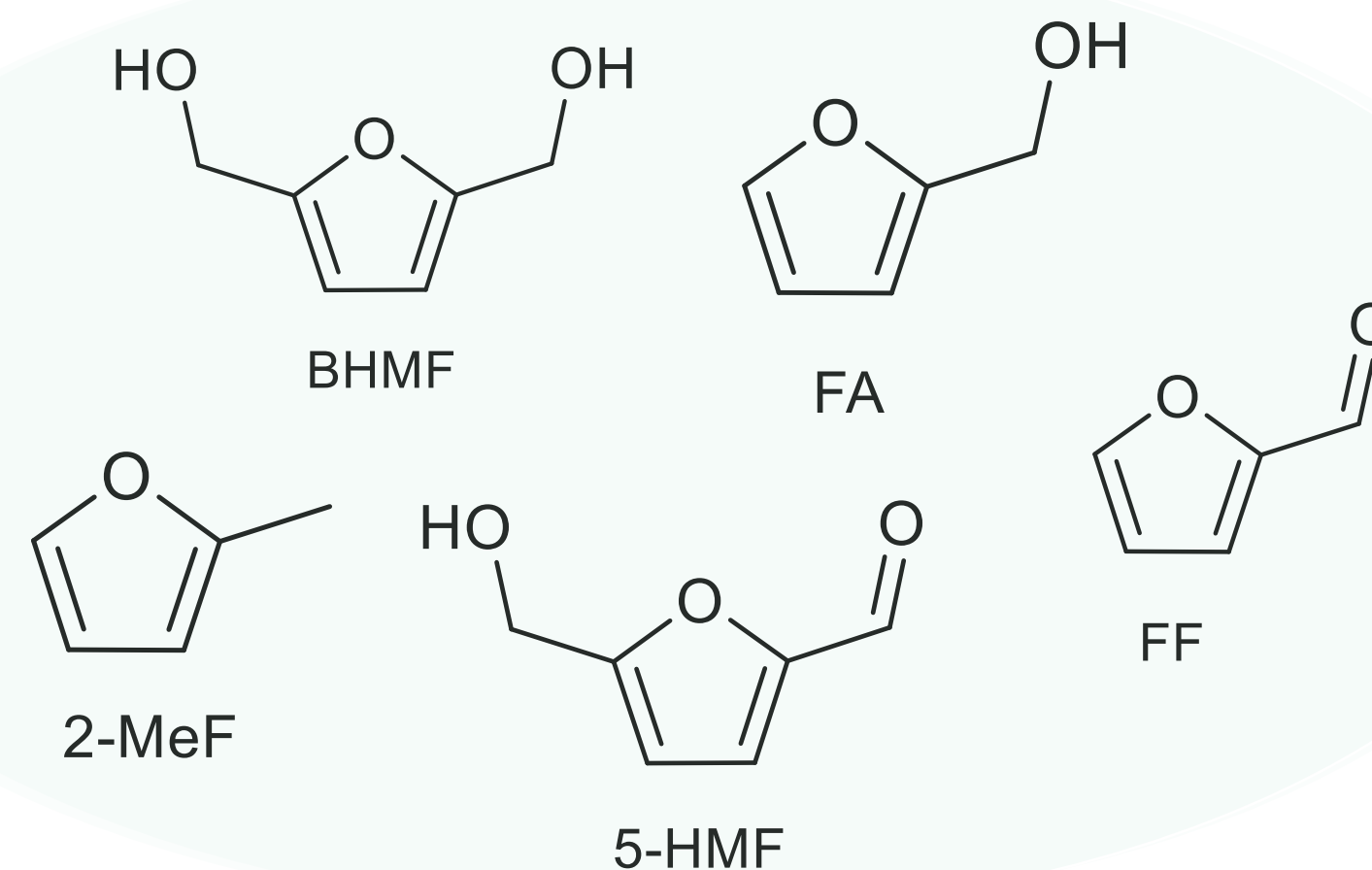


Upgrading of HMF and other furan
derivatives

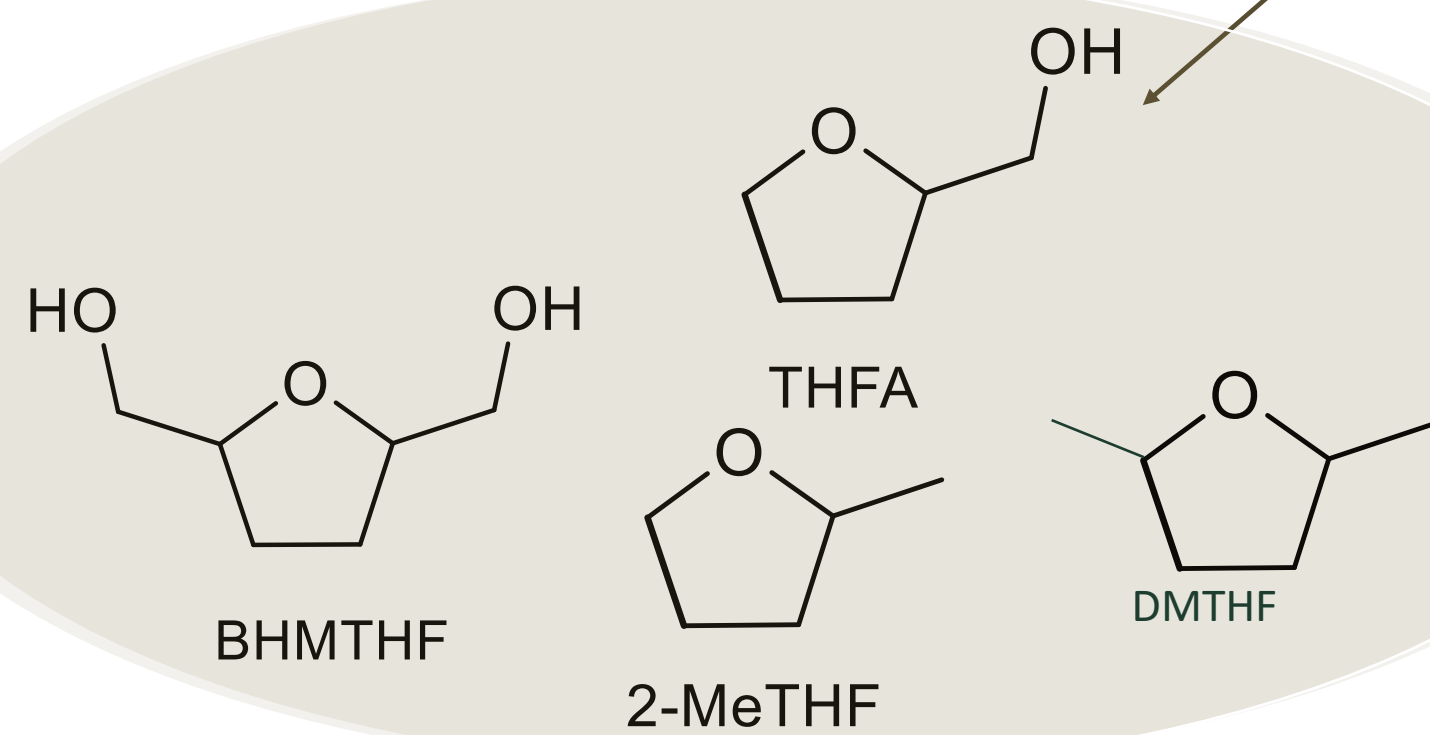


Innovative green chemicals from furanic derivatives

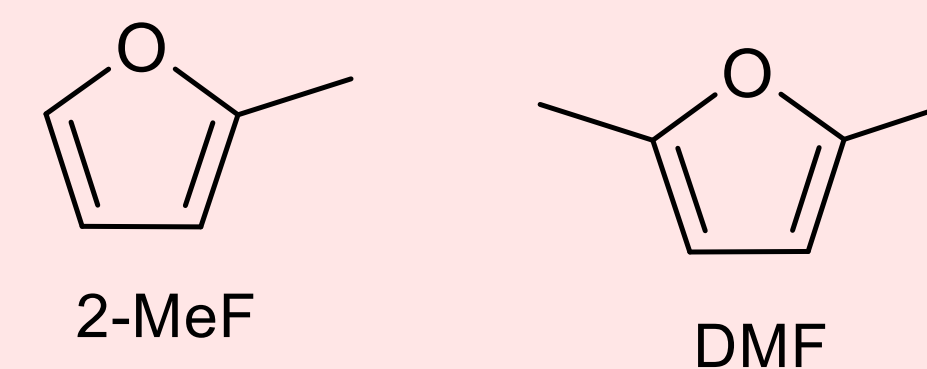
Furanic derivatives



Hydrogenation

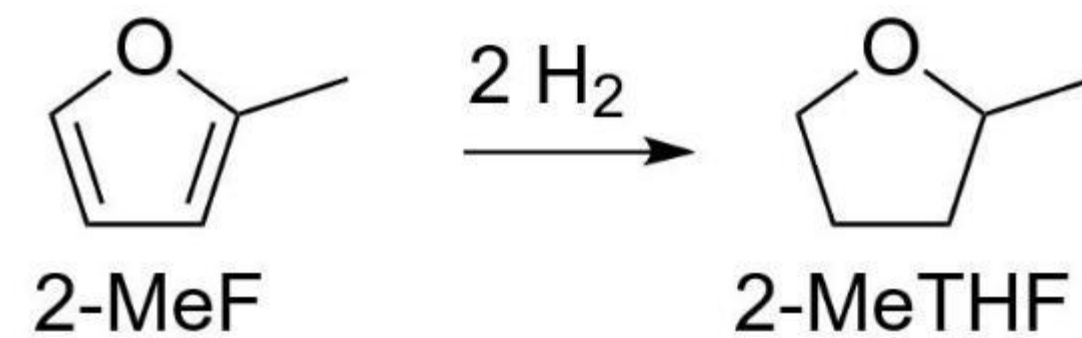


Defunctionalization

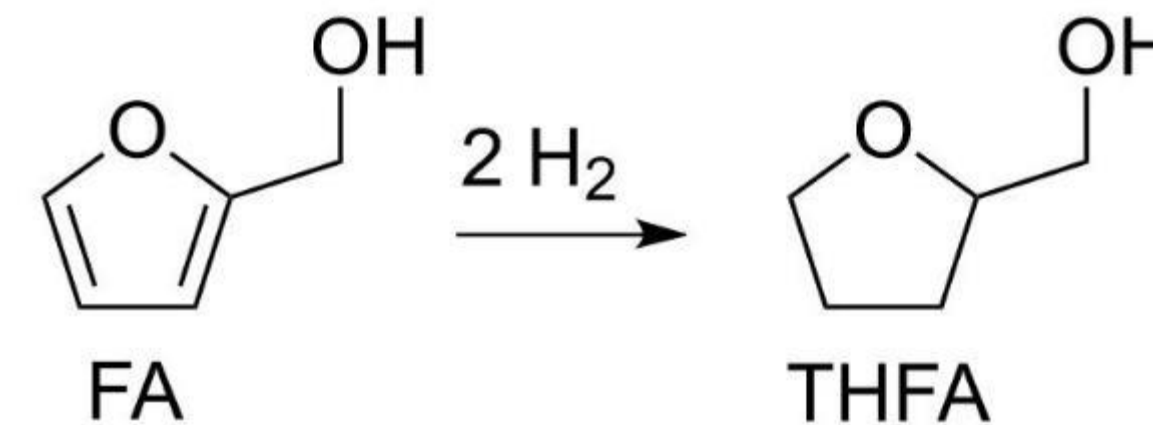


Hydrogenation of various furan derivatives

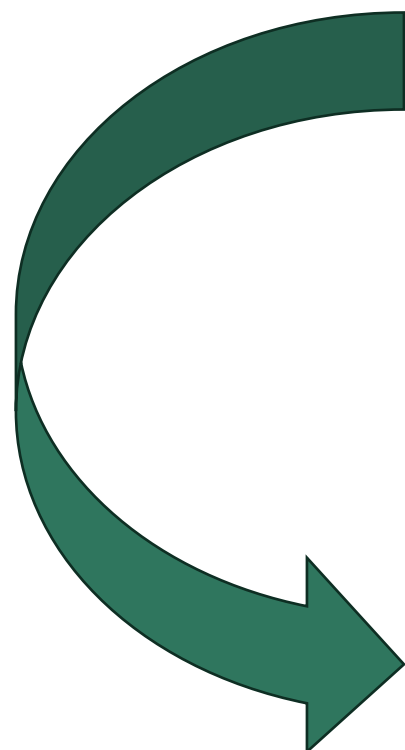
2-Methylfuran to 2-Methyltetrahydrofuran



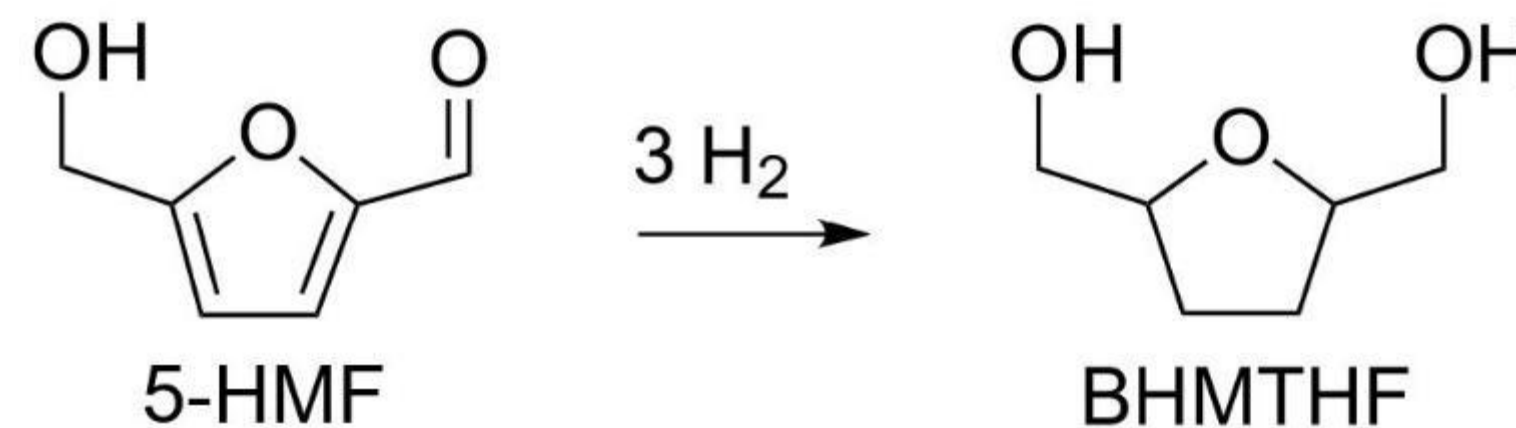
Furfuryl alcohol to Tetrahydrofurfuryl alcohol



Biobased solvents, fuel additives, raw materials for API's, cosmetics, agrochemicals ...
Existing and growing markets



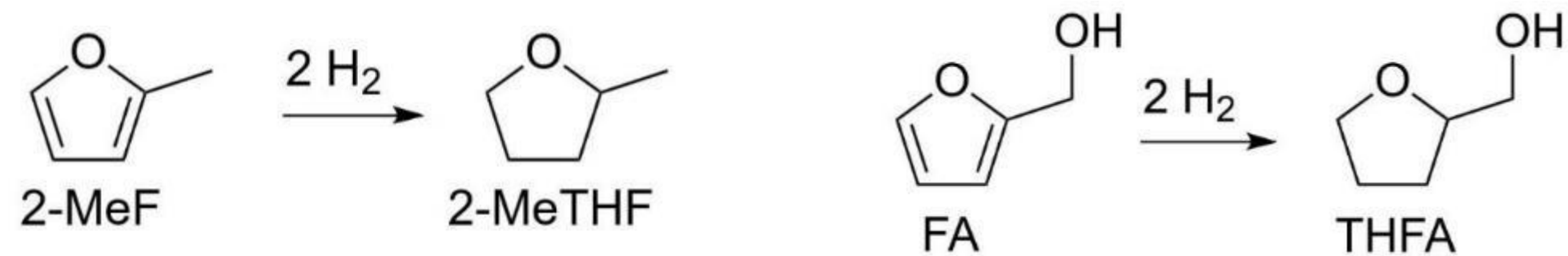
5-Hydroxymethylfurfural to Bishydroxymethyltetrahydrofuran



Biobased diol with potential applications in
polyesters, polyacrylates, polyurethanes,...

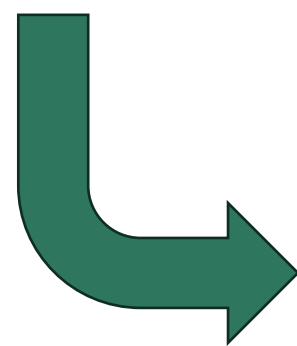
New applications and markets

Hydrogenation of various furan derivatives

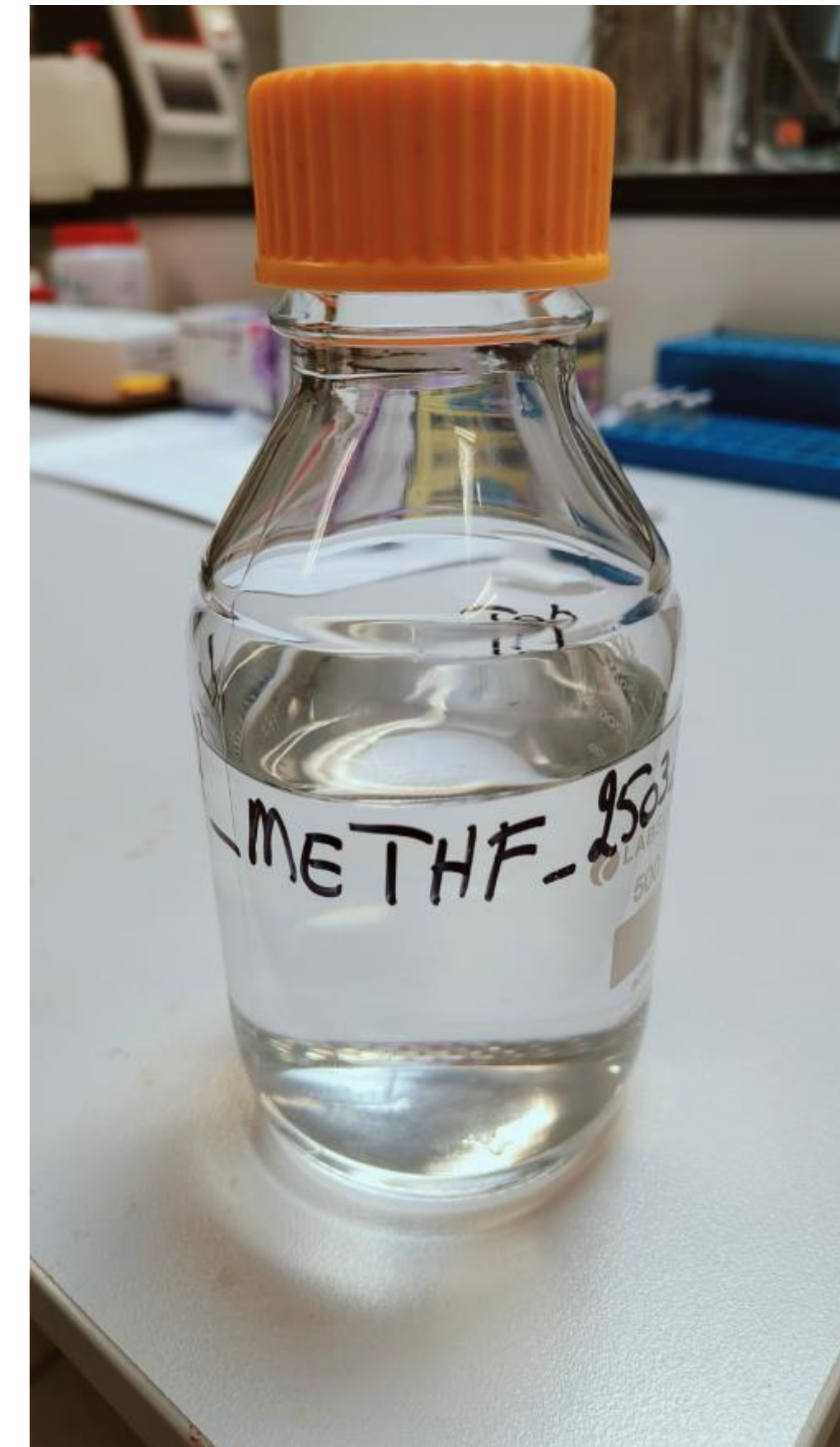


Hydrogenation process developed by TFC

- Developed by TFC optimized during the NewWave project
- Catalyst development
 - > 99% selectivity
 - Improved process control and safety



Commercial plant with capacity > 4 kton / year (startup Q1 2025)
TRL 4 to 9 during the NewWave project



First batch of 2-MeTHF from TFC plant (Q1 2025)

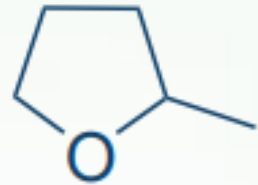
Hydrogenation of various furan derivatives



Commercialization of 2-Methyl tetrahydrofuran

Sole producer in Europe

2-Methyltetrahydrofuran



Chemical nature

Chemical name: 2-Methyltetrahydrofuran
IUPAC name: 2-Methyloxolane
Synonyms: Tetrahydro-2-methylfuran, MeTHF
Molecular formula: C₅H₁₀O
Molecular weight: 86.13 g/mol
CAS number: 96-47-9
EC number: 202-507-4

EU REACH

Registration number: 01-2119968920-28-0009 (TFC)

Delivery specifications

Parameter	Specification	Analysis method *
2-Methyltetrahydrofuran purity (excl. BHT) [%]	min. 99.9	AM 112
Butylated Hydroxytoluene (BHT) [ppm]	150 - 400	AM 131
Moisture content [wt%]	max. 0.03	AM 110
Peroxides (as H ₂ O ₂) [ppm]	max. 15	AM 111
APHA colour	max. 20	AM 109



Applications

- Use as solvent in chemical synthesis, for grignard reactions or organometallic reactions
- Use in solvent recovery, as an extraction solvent
- Use as additive in bio-fuels

Hydrogenation of various furan derivatives



Commercialization of Tetrahydrofurfuryl alcohol

Sole producer in Europe

Tetrahydrofurfuryl Alcohol

OCC1OCCC1

Chemical nature
Chemical name:
IUPAC name:
Synonyms:

Molecular formula:
Molecular weight:
CAS number:
EC number:

Tetrahydrofurfuryl alcohol
(Oxolan-2-yl)methanol
Tetrahydrofuran-2-yl methanol, THFA, 2-hydroxy-methyltetrahydrofuran, tetrahydro-2-furan-carbinol, tetrahydro-2-furylmethanol

C₅H₁₀O₂
102.13 g/mol
97-99-4
202-625-6

EU REACH
Registration number:

01-2119968921-26-0009 (IFC)

Delivery specifications

Parameter	Specification	Analysis method *
Tetrahydrofurfuryl Alcohol purity [%]	min. 99.0	AM 115
Furfuryl Alcohol [%]	max. 0.08	AM 115
1,2-Pentanediol [%]	max. 0.30	AM 115
Moisture content [wt%]	max. 0.10	AM 114
APHA colour	max. 20	AM 113

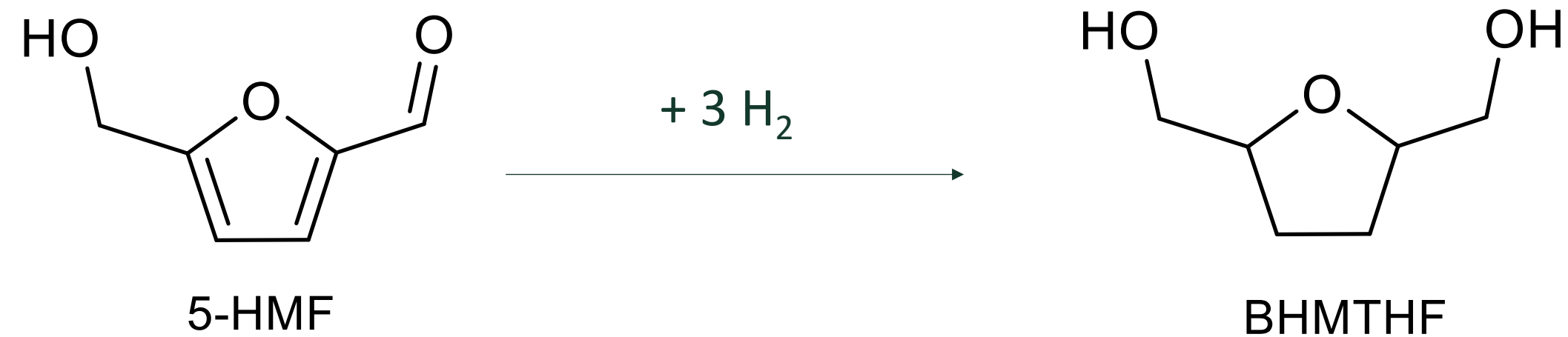
* Available on request



Applications

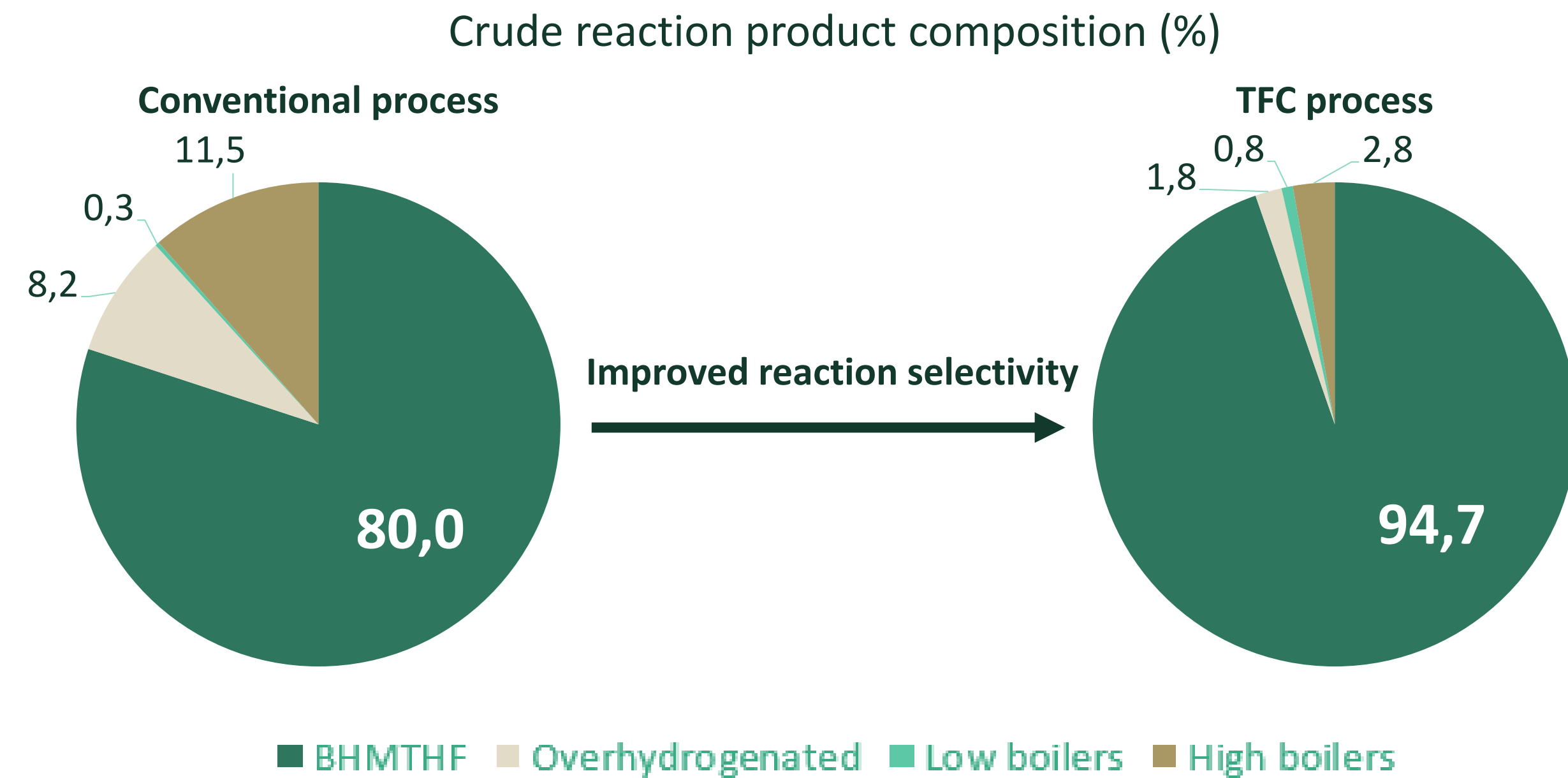
- Use as (cleaning) solvent, a.o. in electronics industry
- Use as synthetic intermediate
- Use in resins (prepolymers), sealants and adhesives
- Use as laboratory reagent
- Use in the formulation of agrochemicals

Hydrogenation of 5-HMF to BHMTHF



5-HMF from project partners

- ≥ 99.0 wt% crystals
- ≥ 95.0 wt% crystals
- 25 ± 5wt% aqueous solutions



Hydrogenation of 5-HMF to BHMTHF



Challenges

- Catalyst lifetime limited due to impurities in HMF source
- Aldehyde group hydrogenation requires other active catalyst sites than aromatic hydrogenation
- Formation of solid byproducts

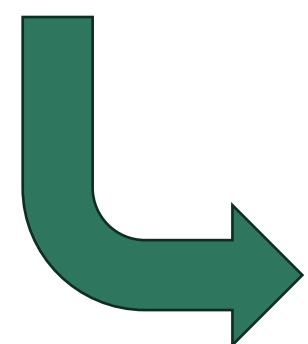


Catalyst development required

Catalyst development & process optimization

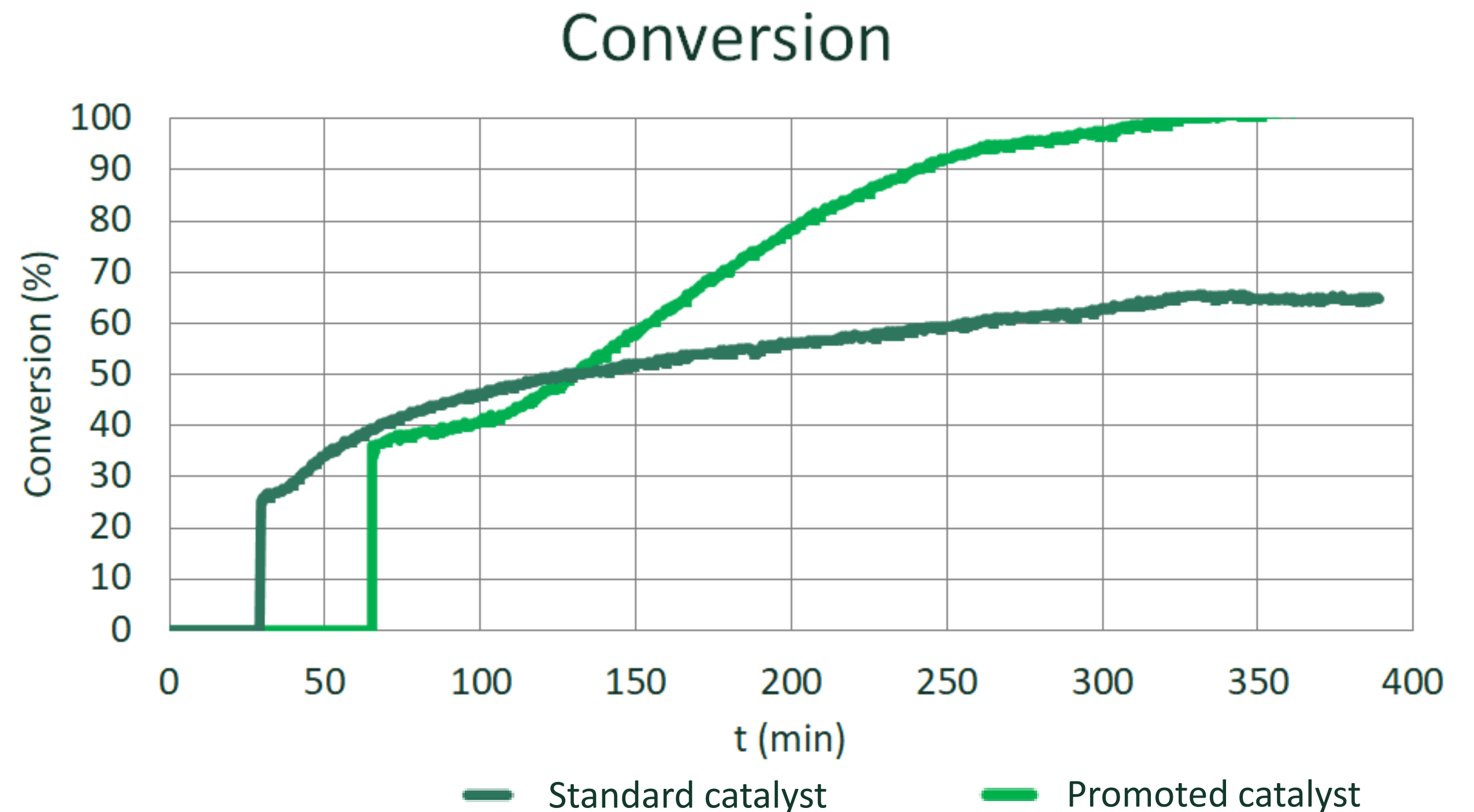
Standard catalyst

Rapid loss of activity (~1 run)



Promoted catalyst

More tolerant to HMF impurities and improved activity towards aldehyde groups
Strong improved lifetime while maintaining high selectivity (+- 95 to 90% over time)
-> Catalyst development for further improvement ongoing



Purification of BHMTHF

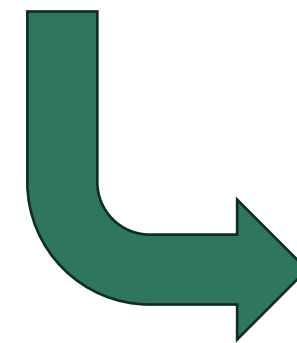


Crude BHMTHF (left) and Purified BHMTHF (right)

> 98% BHMTHF
Clear to slightly yellowish liquid
Density: 1,15 g/mL
Viscosity: 205 cPs (25 °C)

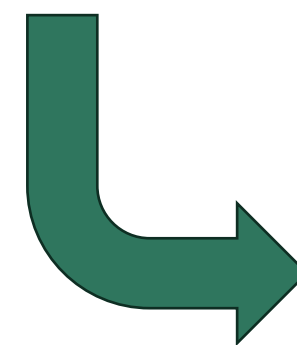
Purification of BHMTHF

- Purification by vacuum distillation
- Produced > 500 g of sample with > 98% purity



Sample sent to AEP for preliminary testing

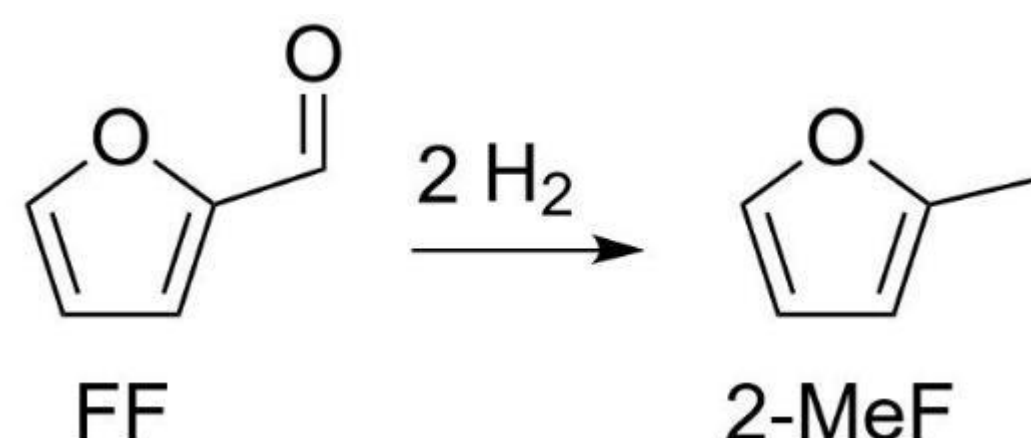
- Limited amount of tests (no scope of the project)
- No improved performance yet with BHMTHF



Currently +/- 1 kg of purified BHMTHF available at TFC

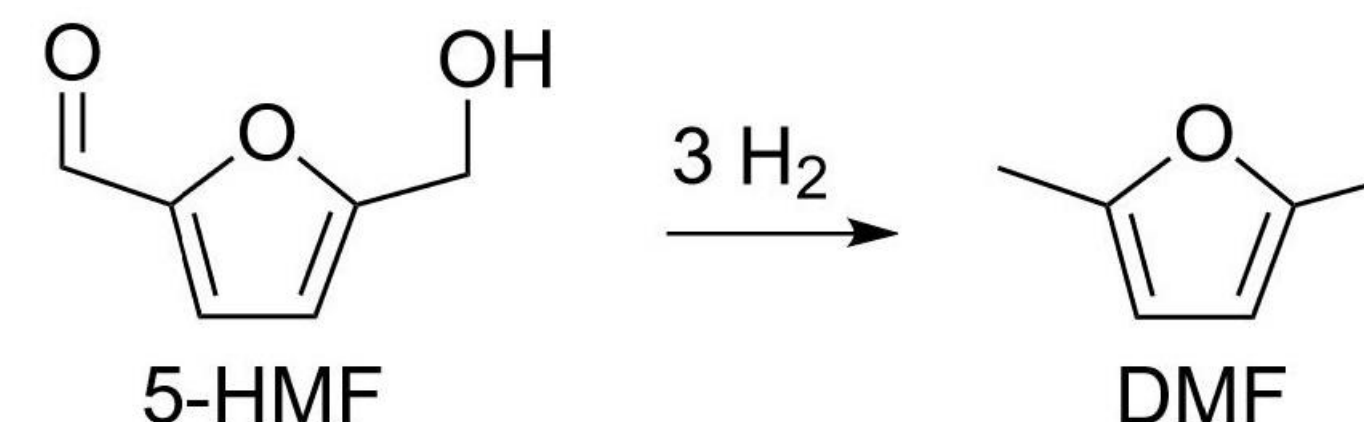
- Opportunity for samples

Defunctionalisation / hydrogenolysis of furan derivatives



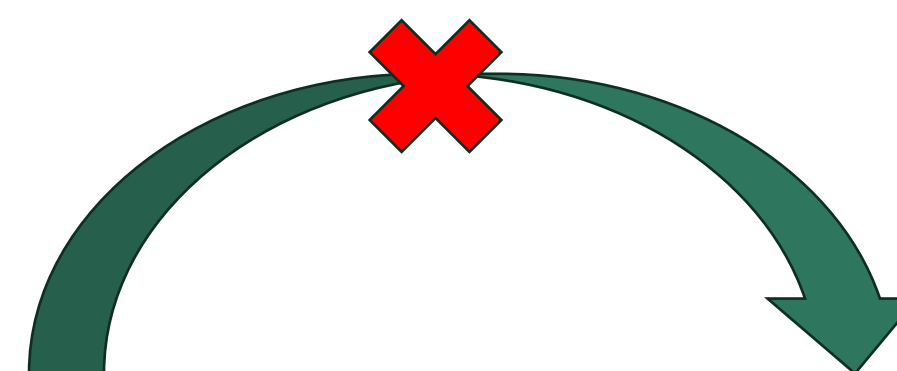
Continuous gas-phase process

Cu-chromite catalyst is industrial standard



2-MeF process not applicable for HMF

HMF is not volatile and too reactive for vaporization



Developed a Cr-free bimetallic catalyst
Screened and optimized reaction conditions

→ Up to 80% selectivity to 2-MeF achieved (95% if including furfuryl alcohol)



Same catalyst, **Liquid-phase process**

Preliminary testing (no optimization yet)

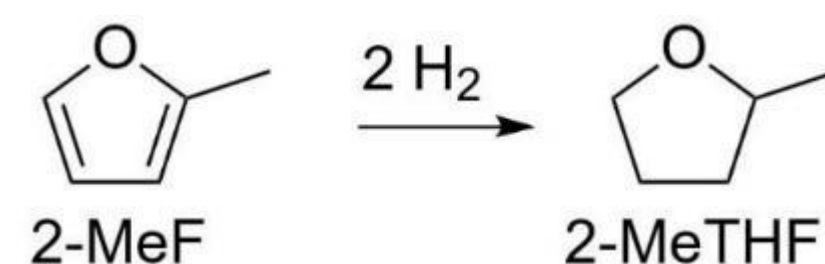
- 90% conversion, 30% DMF
- Approx 40% intermediates

Challenges & improvements

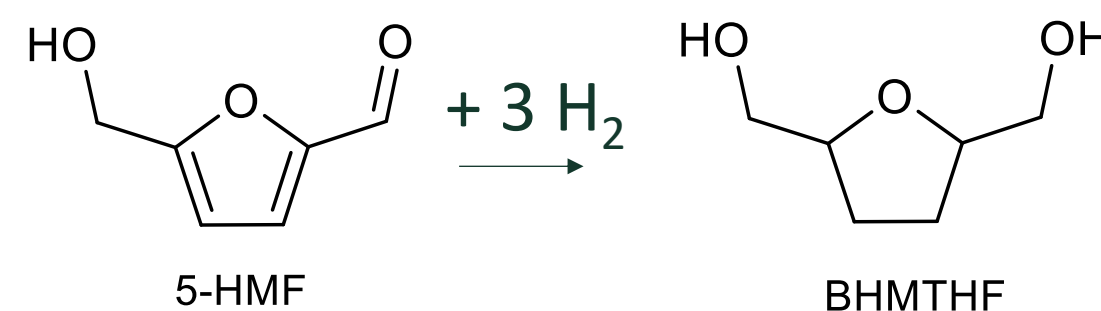
- Product recovery (separation from water and condensation of 2-MeF)
- Catalyst lifetime for industrial process (regeneration of catalyst)

Likely entire different process required

Summary



Improved TFC's developed hydrogenation process
Catalyst improvement
Commercial unit constructed and commissioned

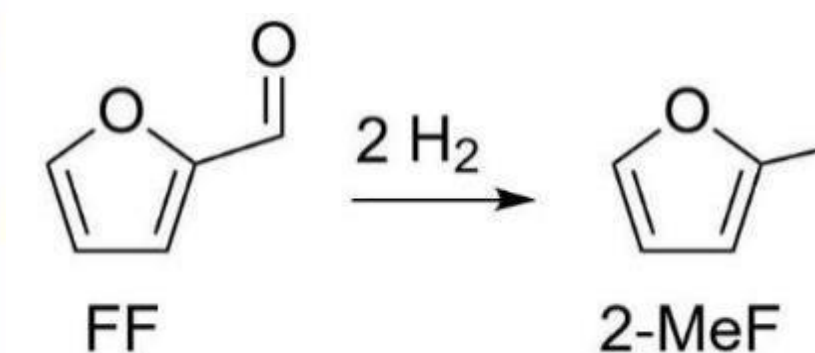
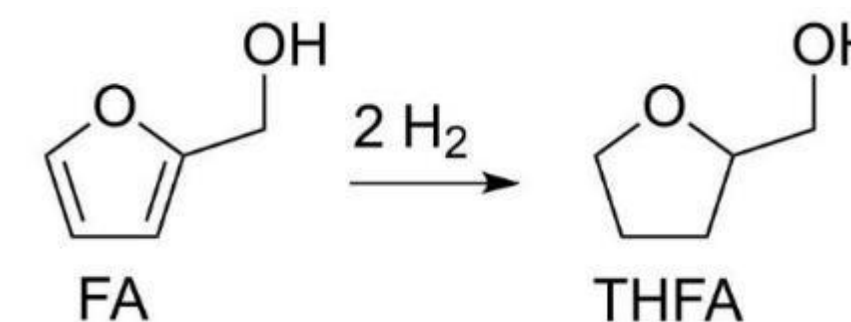


Catalyst development, proof of concept, purification and availability of samples

Future work to increase TRL:
Improve catalyst, increase lifetime, more tolerant to HMF impurities (use of crude HMF)

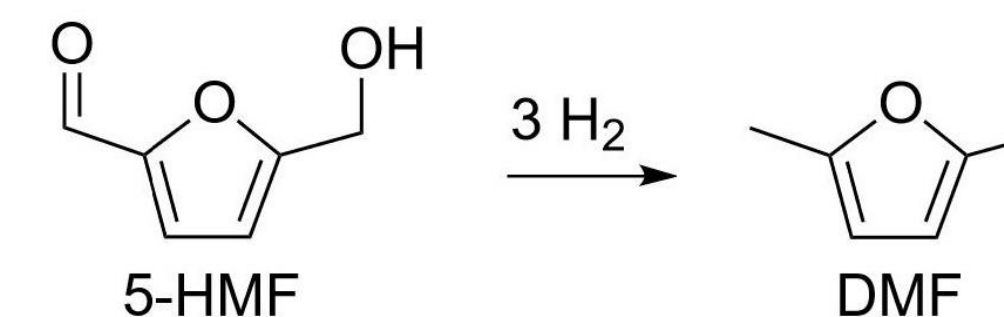
TECHNOLOGY READINESS LEVEL (TRL)

DEPLOYMENT	9	ACTUAL SYSTEM PROVEN IN OPERATIONAL ENVIRONMENT
	8	SYSTEM COMPLETE AND QUALIFIED
	7	SYSTEM PROTOTYPE DEMONSTRATION IN OPERATIONAL ENVIRONMENT
	6	TECHNOLOGY DEMONSTRATED IN RELEVANT ENVIRONMENT
RESEARCH	5	TECHNOLOGY VALIDATED IN RELEVANT ENVIRONMENT
	4	TECHNOLOGY VALIDATED IN LAB
	3	EXPERIMENTAL PROOF OF CONCEPT
	2	TECHNOLOGY CONCEPT FORMULATED
	1	BASIC PRINCIPLES OBSERVED



Developed a Cr-Free catalyst
Optimized conditions

Future work to increase TRL:
Product recovery and catalyst lifetime (regeneration)



Proof of concept

Future work to increase TRL:
Catalyst and process development

Thank you!

 New Wave Project

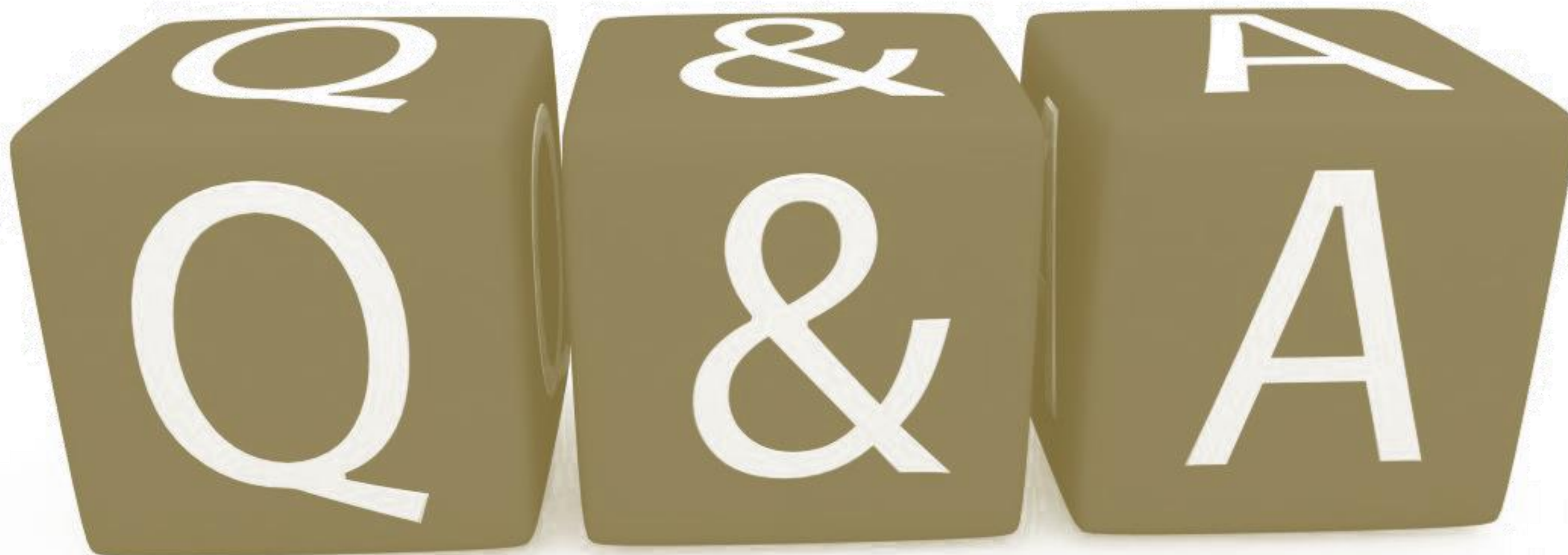
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Building a sustainable & circular economy through innovative, biobased manufacturing lines





Thank you!

 New Wave Project

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Member of



BIOMATTERS

Manufacturing technologies
for bio-based materials

The NewWave consortium



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