FACULTY OF BIOSCIENCE ENGINEERING

DEPARTMENT OF ENVIRONMENT
LABORATORY OF WOOD TECHNOLOGY (UGENT-WOODLAB)

ENHANCING RESISTANCE AGAINST DECAY AND IMPROVE FIRE SAFETY OF ENGINEERED WOOD PRODUCTS

Joris VAN ACKER,
Xiuping Jiang, Marcy Durimel, Liselotte De Ligne, Bogdan Parakhonskiy°, Andre Skirtach°,
Jan Van den Bulcke
(°*UGent Research Group on Nano-Biotechnology*)

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cnrs GDR Groupement de recherche Sciences du bois GDR 3544

12e Journées Scientifiques
Limoges 22-24 novembre 2023

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ENGINEERED WOOD PRODUCTS

APA – THE ENGINEERED WOOD ASSOCIATION | June 22, 2023

Meng Gong, 2021

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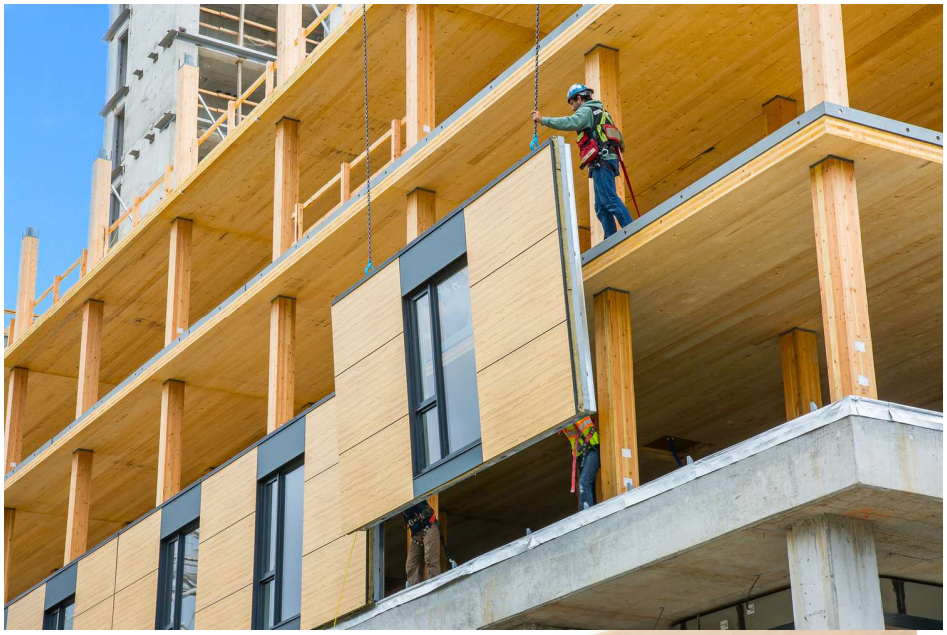
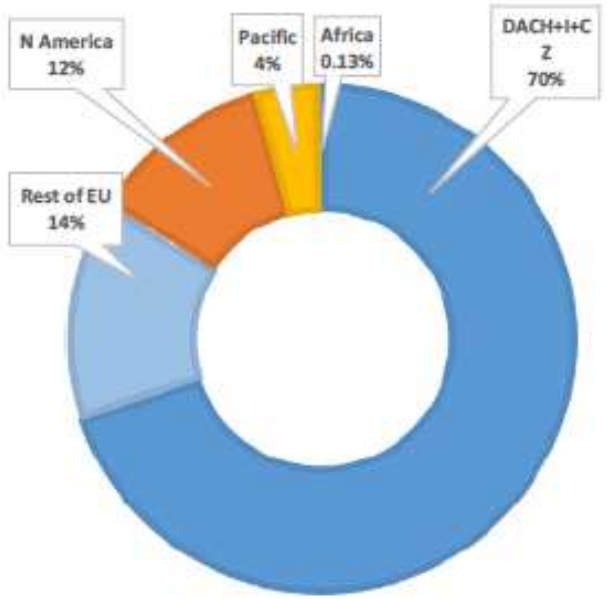
GREEN BUILDING WITH CLT





The global annual output of the CLT industry in 2019 that we can attribute to 60 specific production lines was about 1.44 million m^3 (Larasatie et al. 2021)

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LIGHT WOOD FRAME CONSTRUCTION

1. Facade cladding (type, thickness, density, vertical/horizontal arrangement, …)
2. Ventilated air cavity behind the cladding
3. System and method of fixing
4. Layers located behind the air cavity (insulation, wood panels, ...)

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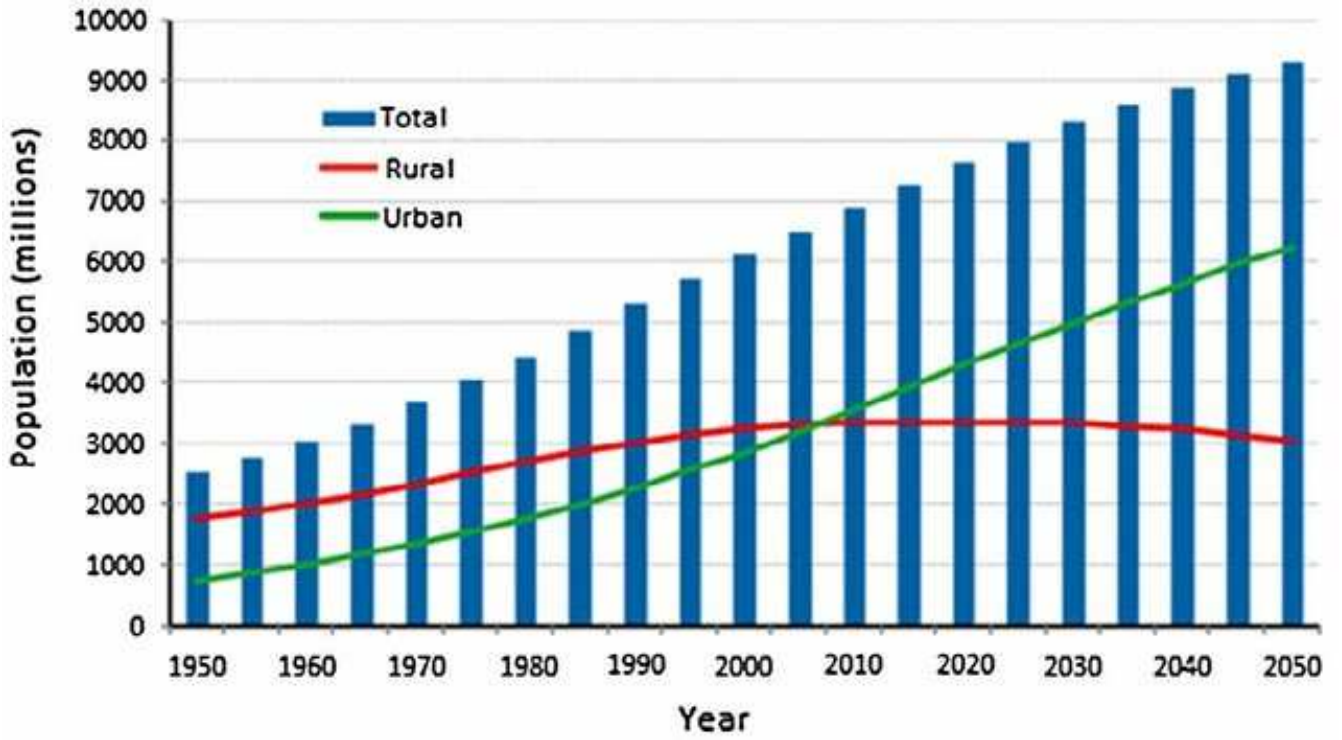
URBANIZATION

Today, more than half of the global population lives in urban areas, up from around one-third in 1950 and projected to increase to around two-thirds in 2050.



World's urban and rural population, 1950–2050. (Musa et al 2017)

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GREEN BUILDING & BIO-BASED MATERIALS

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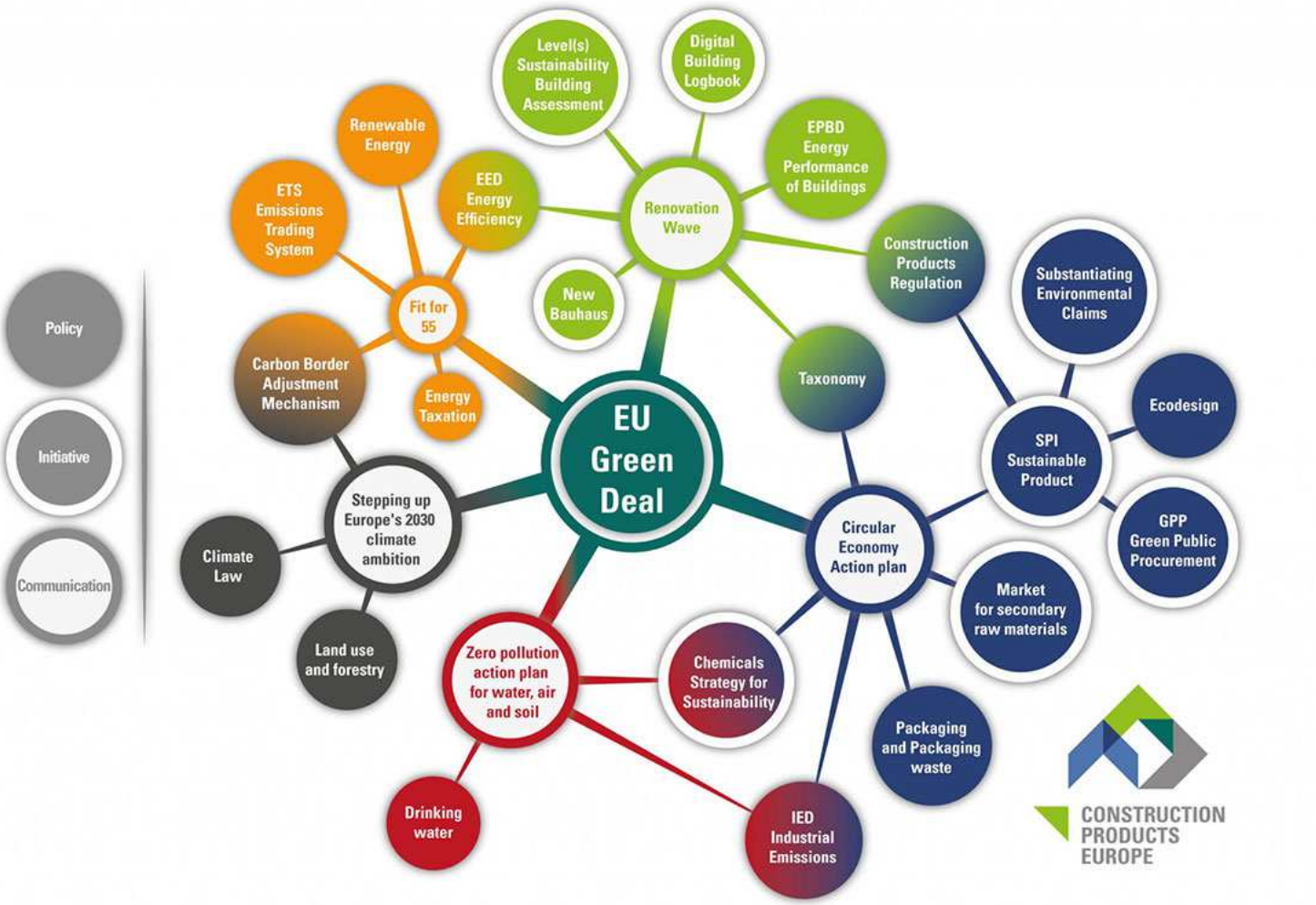
GREEN BUILDING & BIO-BASED MATERIALS



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GREEN BUILDING & BIO-BASED MATERIALS

New European Bauhaus

A New European Bauhaus

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DECAY RESISTANCE & FIRE SAFETY + RETARDANCY

Dead wood in the forest – WWF France

Forest fires in SW France 2022

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LONG LASTING HARVESTED WOOD PRODUCTS

Sakyamuni Pagoda – 1056 CE – Yinxian, China

Nanchan Temple – 782 CE – Shan Xi Sheng, China

EU Carbon Removal Certification Framework (CRCF): long-term storage of atmospheric and biogenic carbon in long-lasting harvested wood products or materials for construction for at least five decades

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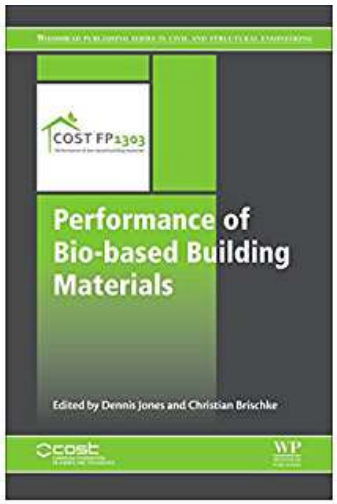
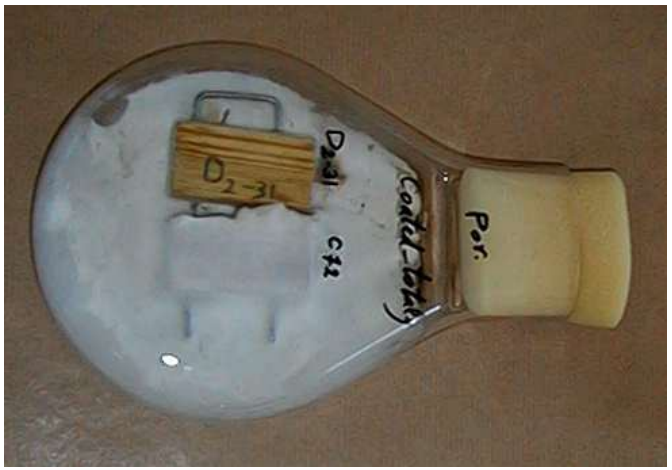
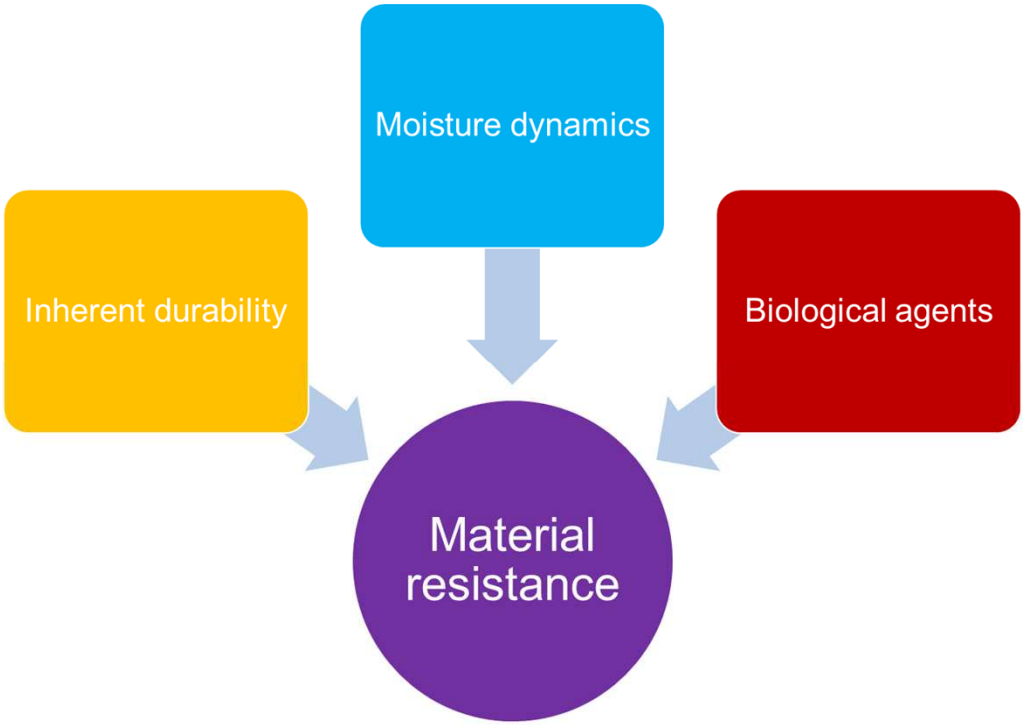
MATERIAL RESISTANCE OF BIO-BASED MATERIALS







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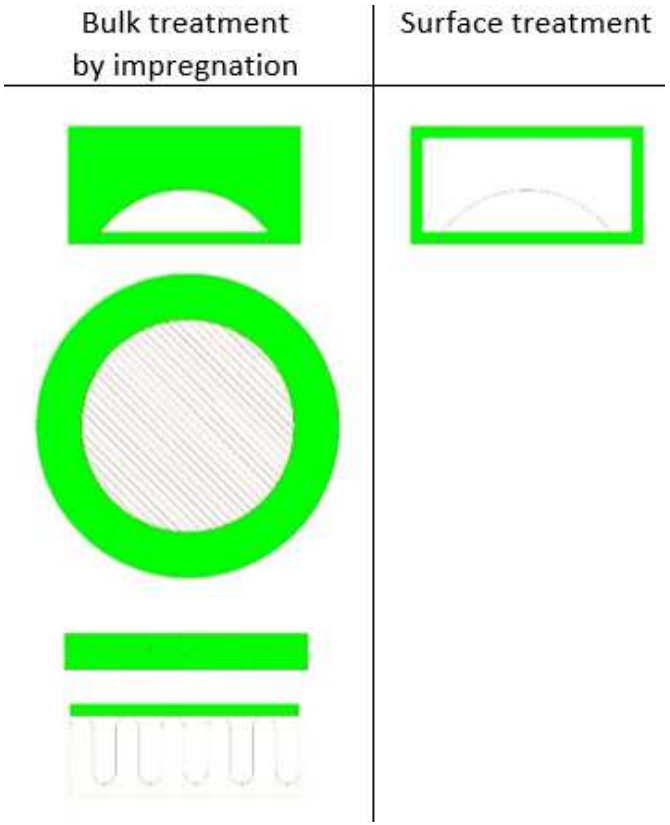
RESTRICTED USE OF BIOCIDES



Biocides Products Regulation (**BPR**): Regulation (EU) No 528/2012: Rules on the making available on the market and the use of biocidal products, whilst ensuring a high level of protection of both human and animal health and the environment.

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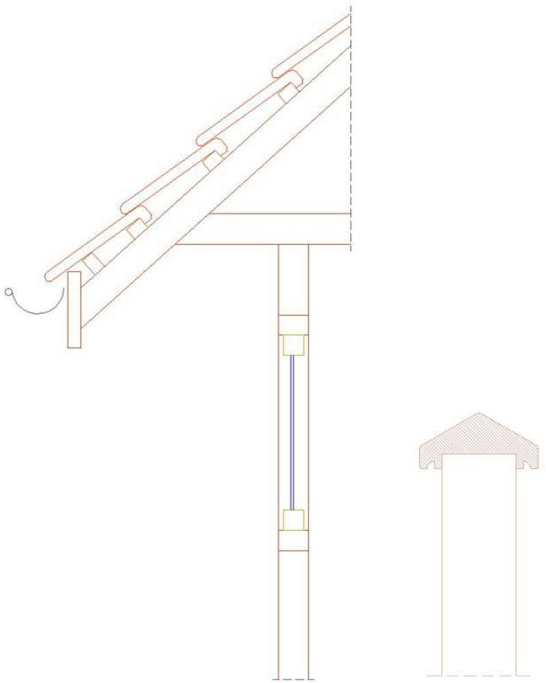
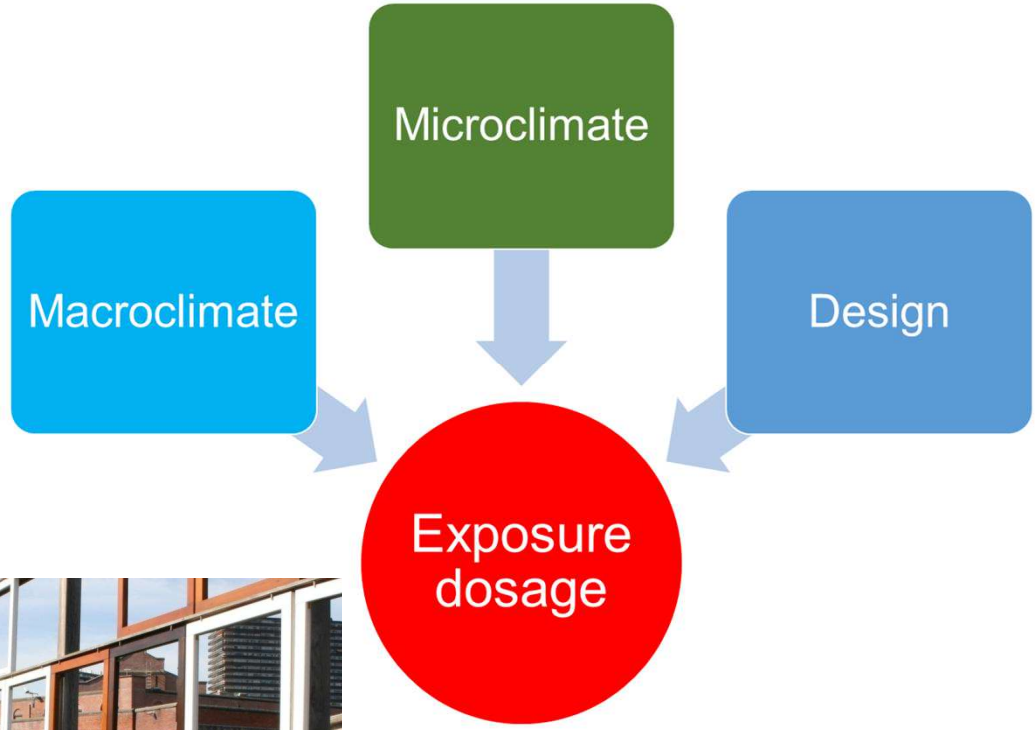
SERVICE LIFE DETERMINED BY MOISTURE DYNAMICS





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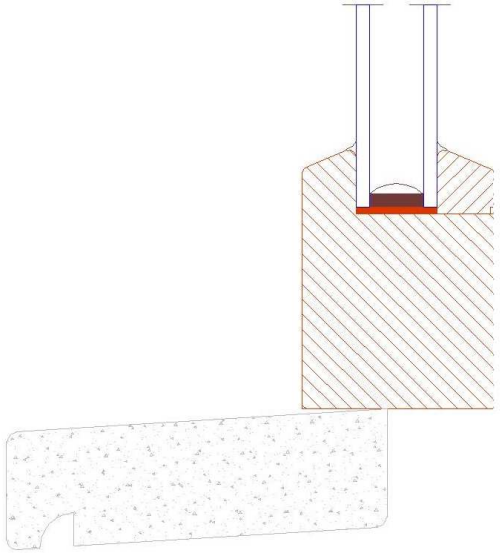
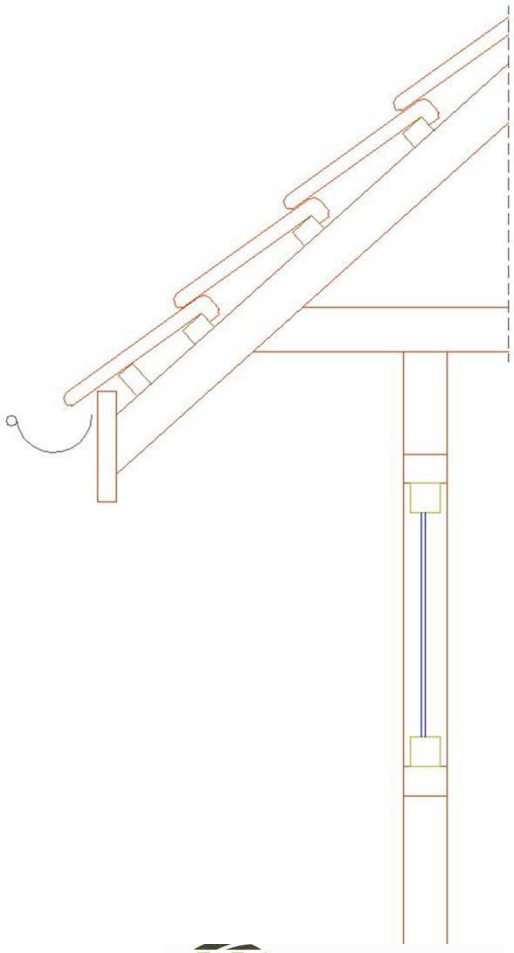
PROTECTION BY DESIGN

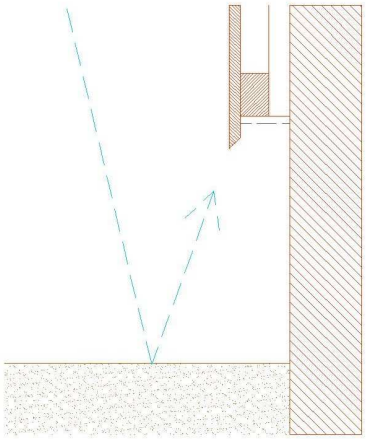
Window frames (rounded edges)



Roof overhang - eave (60° rule)



Protection from splash water



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USE CLASSES – SERVICE LIFE

Service Class	Description
1	Relative humidity of the air surrounding the structure only exceeds 65% for a few weeks per year
2	Relative humidity of the air surrounding the structure only exceeds 85% for a few weeks per year
3	Climatic conditions lead to higher moisture content than in service class 2

Service Classes in Eurocode 5

EN 335:2013 Durability of wood and wood-based products – Use classes: definitions, application to solid wood and wood-based products

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WOOD PRESERVATION

- Toxic threshold values
- Biocides
- Related to use classes
- Traditional focus on UC 4
- Modern approach based on use classes

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SERVICE LIFE PREDICTION

- Focus on use classes 2 and 3
- Important for building with wood: building physics, moisture dynamics
- Important for innovation, e.g. CLT (decay remains critical next to fire…)
- Fit for purpose & benchmarking
- CMM: Continuous Moisture Measurement

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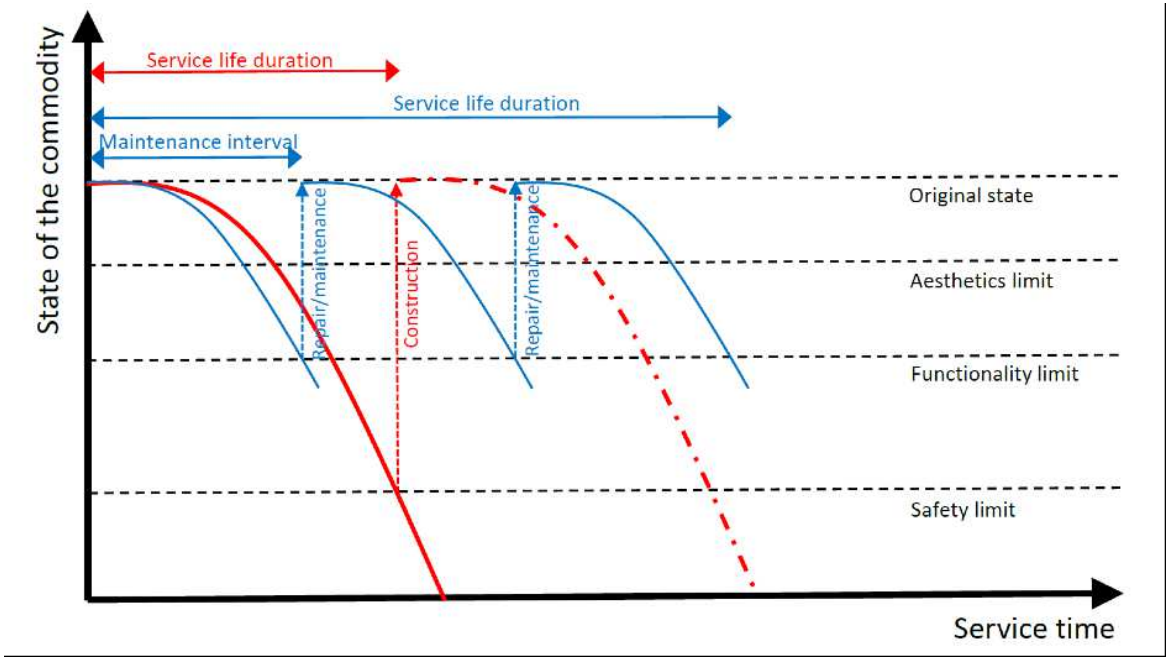
FIT FOR PURPOSE

INTERIOR	EXTERIOR	
USE CLASS 2	**USE CLASS 3(u)**	**USE CLASS 4**
Above the ground or DPC, covered	Above the ground *(uncoated)*	Ground or fresh water contact (and exterior structural support)
Internal construction timbers within the building envelope: **Tiling battens, framing and roof timbers, internal joists, sole plates.**	External construction timbers: **Deck boards, fence rails and boards, cladding** (including battens) **and fascias.**	External construction timbers: **Fence posts, agricultural timbers, retaining walls, playground equipment, decking posts, joists and sub-structures.**

WPA website



BRE website CLICK Design project

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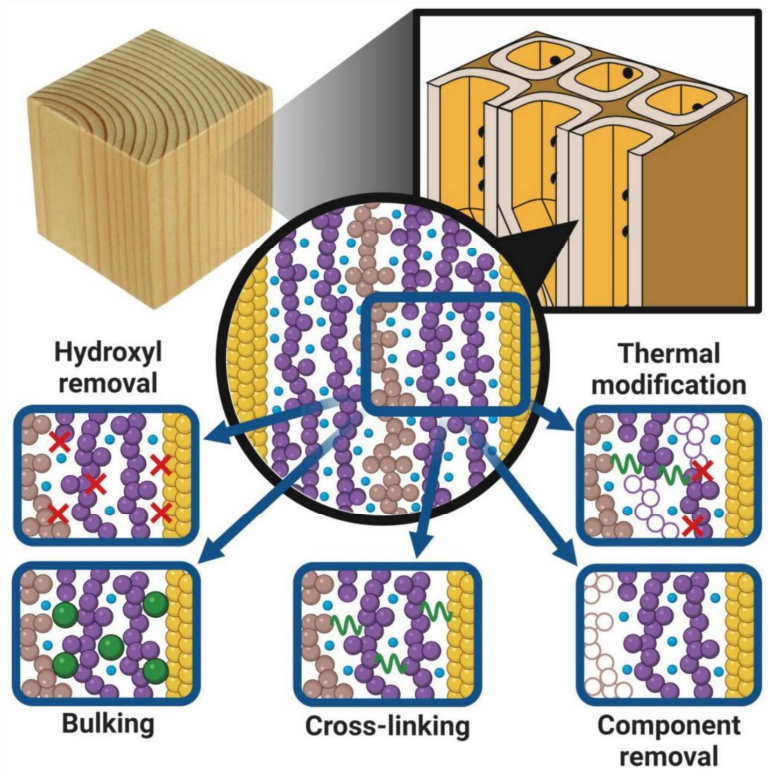
WOOD MODIFICATION



Thybring and Frederiksson 2021

Chemical processes	Thermally-based processes
Active modification • Acetylation (Accoya™) • Resin impregnation - Compreg™ - PF-resin - Other type of chemicals • Furfurylation - Kebony™ - Other types, e.g Keywood™ Nobelwood™ • DMDHEU - Belmadur™, HartHolz™ • Silicate/silane-based	**Thermo treatment** • Charring of wood surfaces **Thermo-hydro treatment** • Releasing internal stresses • Softening • Drying • Ageing • Thermal modification **Thermo-mechanical treatment** • Self-bonding of veneer • Frictional wood welding

Jones and Sandberg 2020

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OPTIONS TO INCREASE SERVICE LIFE OF ENGINEERED WOOD PRODUCTS (EWP)

Component	EWP	Durable wood	Vacuum pressure[1]	Glue-line additive	Surface spray[2]	Thermal modification	Chemical modification	Resin[3]	Coatings
Strand	OSB	-	-	±	+	+	+	+	-
	LSL	-	-	±	±	-	-	+	-
Veneer	PLY	+	+	+	+	+	±	+	+
	LVL	±	±	+	±	±	±	+	+
Timber	CLT	+	+	-	+	+	±	±	+
	GLT	+	+	-	±	±	±	±	+

Legend: +: existing option, ±: feasible option, -: less probable option

[1]: deep impregnation with biocides;

[2]: surface biocide application with potential diffusion, e.g. borates,

[3]: analogue to glue used for production or a hydrophobing agent;

Abbreviations: EWP = engineered wood product; OSB = oriented strand board; LSL = laminated strand lumber; LVL = laminated veneer lumber; CLT = cross laminated timber; GLT = glue laminated timber or glulam.

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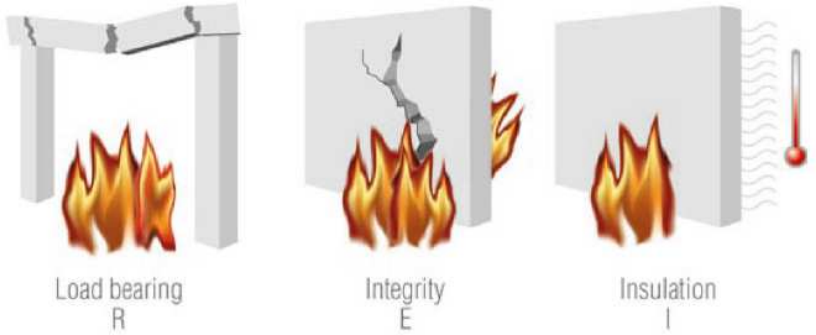
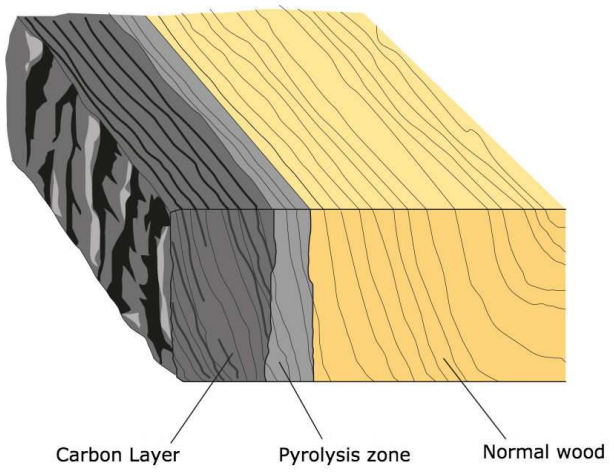
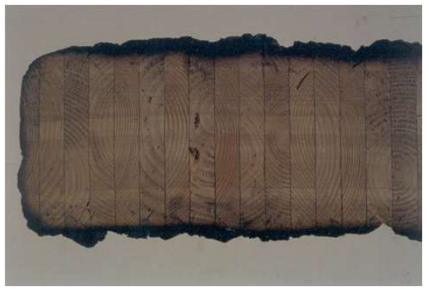
FIRE SAFETY

- Fire resistance class criteria



- In contrast to unprotected steel, wood retains its load-bearing capacity in a fire





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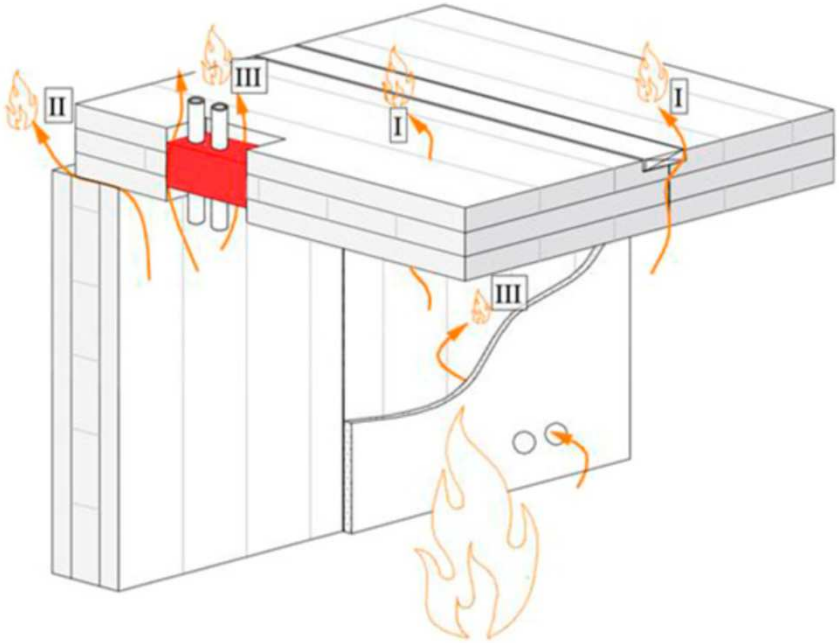
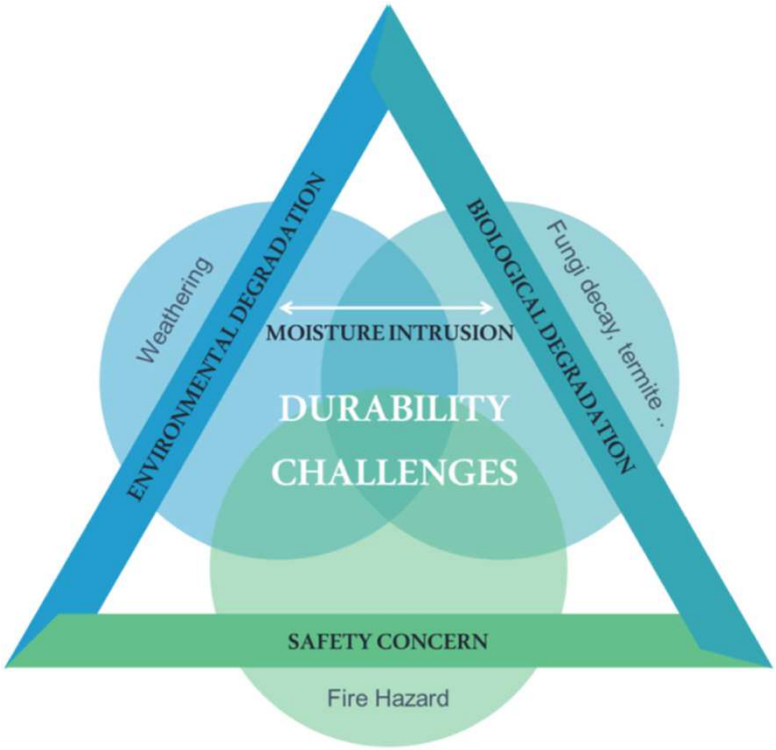
COMBINING WOOD PROTECTION OPTIONS



Östman et al 2018



Ayanleye et al 2022

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SWOT ANALYSIS

Wood protection & Green building

	Resources	*Production*	*Use*	*Disposal*
Strengths	Renewable, sustainable Bio-based	Many options Less energy required	Substitution man-made Low energy housing	Embodied energy Biodegradability
Weaknesses	Max on availability Forestry economics	Internal competition Logistics transport	Biodegradation Low fire resistance	Environmental impact Recovery sorting
Opportunities	Fast growing trees Engineered Wood Prod.	Value added products Local rural production	Extended CO_2 seq. Fire safety	Circularity Cascade use
Threats	Bioenergy Biorefineries	Low on high quality Low industrial lobbying	Impact biocides Inefficiency	Historical treatments Impact CO_2 seq.

Resources

Renewable, sustainable

Bio-based

Max on availability

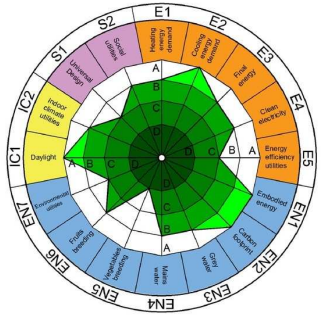
Forestry economics

Fast growing trees

Engineered Wood Prod.

Bioenergy

Biorefineries



Sadowski 2021

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Production

Many options

Less energy required

Internal competition

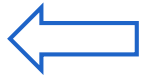
Logistics transport

Value added products

Local rural production

Low on high quality

Low industrial lobbying



Tropical wood

- Sustainable forestry

Wood preservation

- Increased service life

Wood modification

- Fit for purpose

Van Acker IRG50 keynote

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SWOT ANALYSIS

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Use

Substitution man-made

Low energy housing

Biodegradation

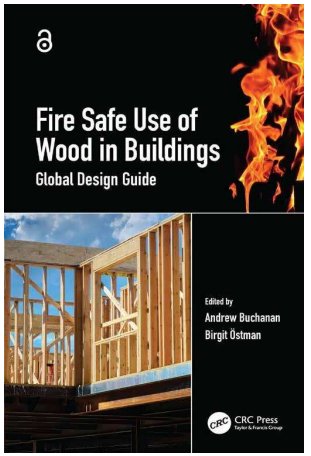
Low fire resistance

Extended CO_2 seq.

Fire safety

Impact biocides

Inefficiency



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SWOT ANALYSIS

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Disposal

Embodied energy

Biodegradability

Environmental impact

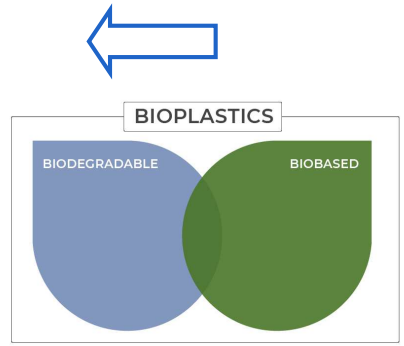
Recovery sorting

Circularity

Cascade use

Historical treatments

Impact CO_2 seq.



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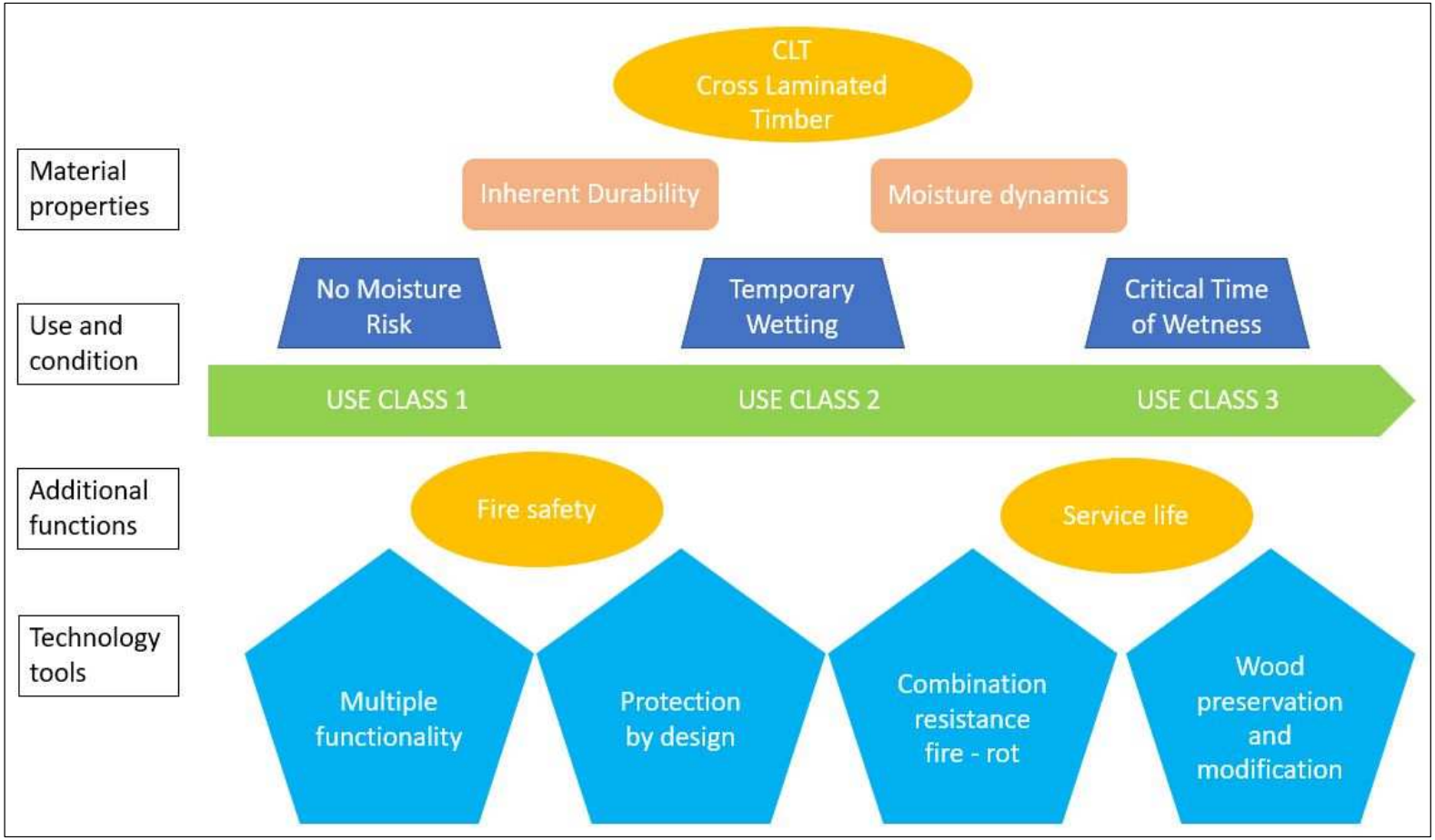
PARAMETERS FOR MULTI CRITERIA DECISION MAKING ON WOOD PROTECTION OF CLT



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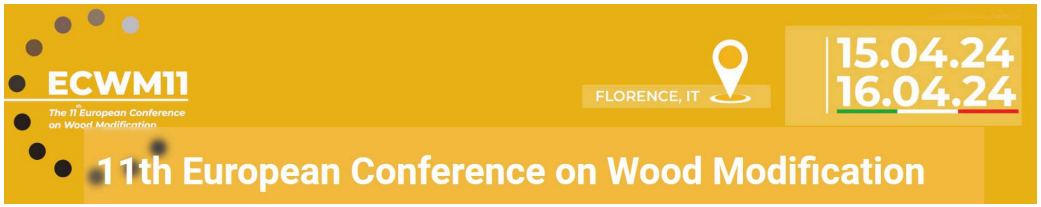
NETWORKING



Wood protection refers to measures that in various ways aim to protect wood and wood-based materials against attacks by destructive organisms.
These include wood-decaying fungi, termites and other wood-destroying insects, marine borers, and discolouring microorganisms such as blue stain and mould.

12th – 15th May 2024 | Hotel Patria
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MARCUS WALLENBERG PRIZE

2019 – Gerhard Schickhofer, Austria

for his role in providing insightful scientific and engineering research data required to standardize wood-based construction products with the rigor necessary for the reliable design of timber structures. His role in the development of **cross-laminated timber (CLT)** has been the key factor in the marked expansion of construction activities in multi-storey wood buildings.

The Marcus Wallenberg Prize

https://www.mwp.org/

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THANK YOU
Prof. Joris Van Acker

UGENT – WOODLAB

Joris.VanAcker@UGent.be
Liselotte.DeLigne@UGent.be
Jan.VandenBulcke@UGent.be

@WoodlabG
@Woodlab.gent
#ugentwoodlab

www.woodlab.be

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