Final dissemination event

Innovative Eco-Construction System Based on Interlocking Modular Insulation Wood & Cork-Based Panels

(IMIP)

Prof. Dr. José Vicente Oliver
Project Coordinator
joolvil@upv.es

Sevilla, 18/04/2023

Introduction to IMIP Project

1. Sustainable wood-based construction in SUDOE
2. IMIP: an innovative eco-construction project based on modular interlocked wood & cork panels
3. Final dissemination event

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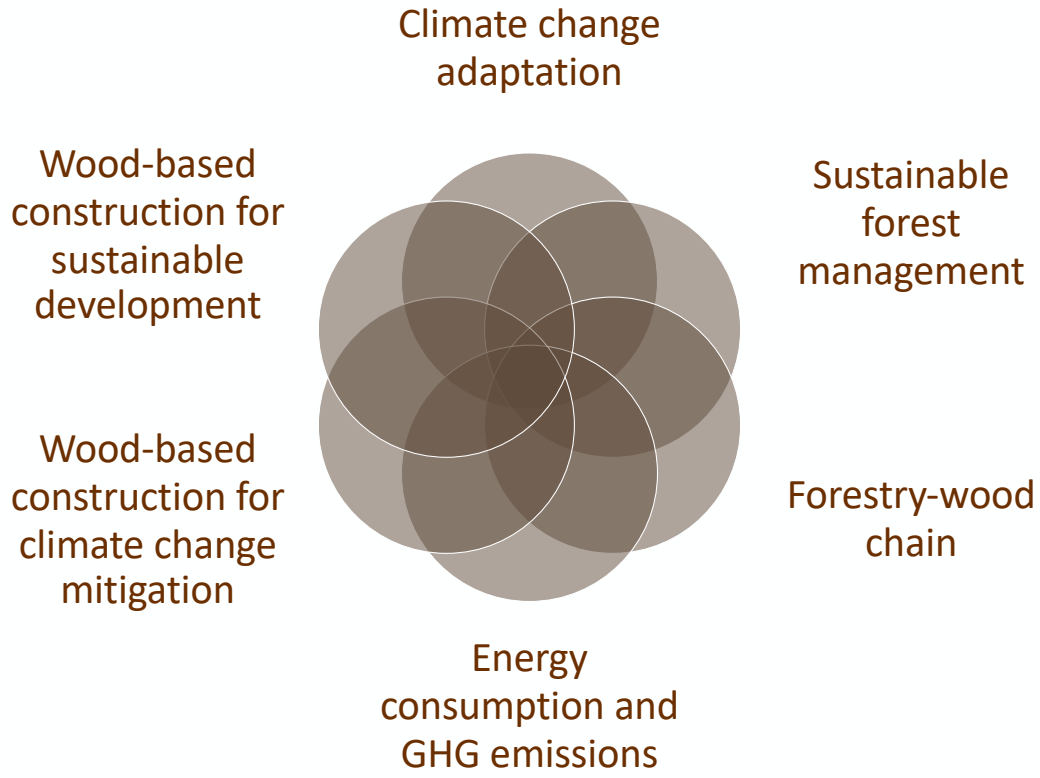
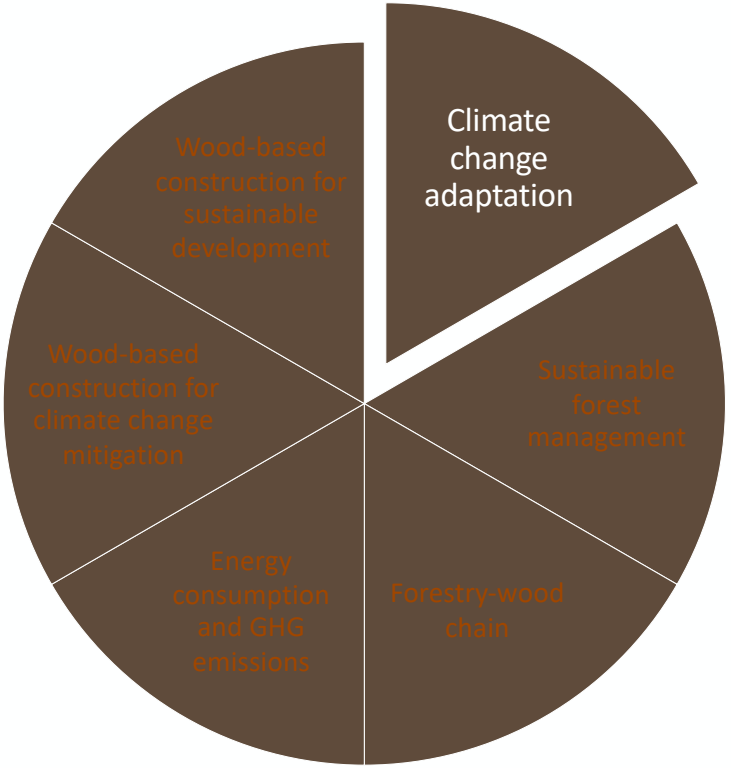
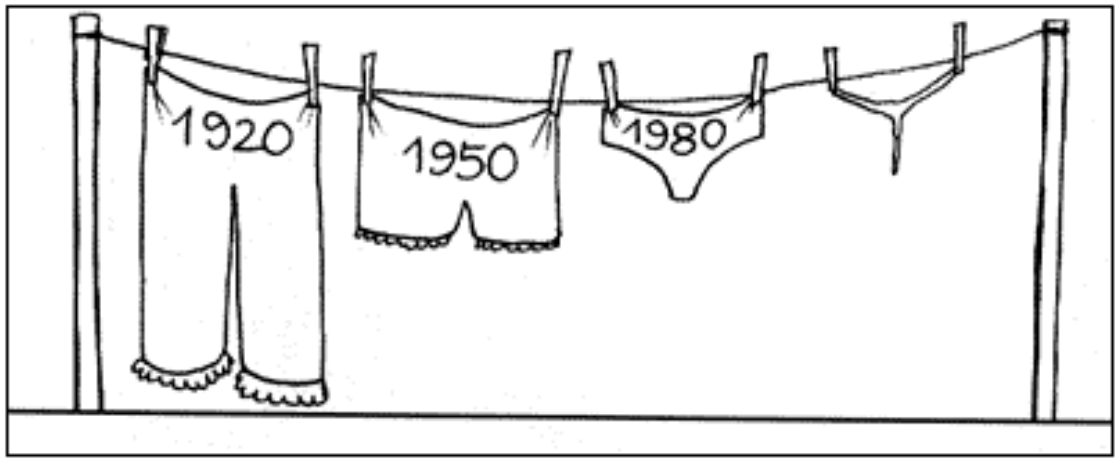
Sustainable wood-based construction in SUDOE

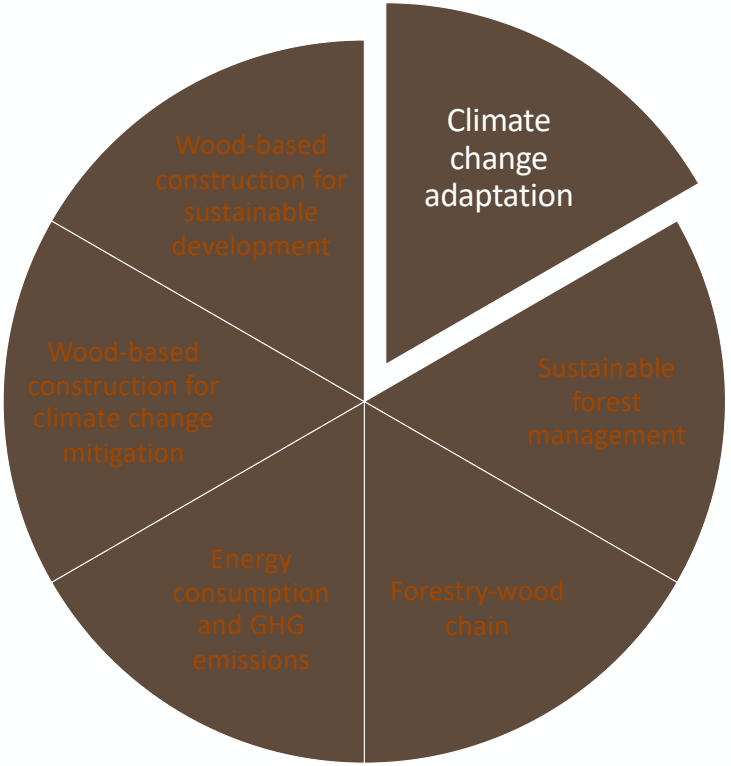


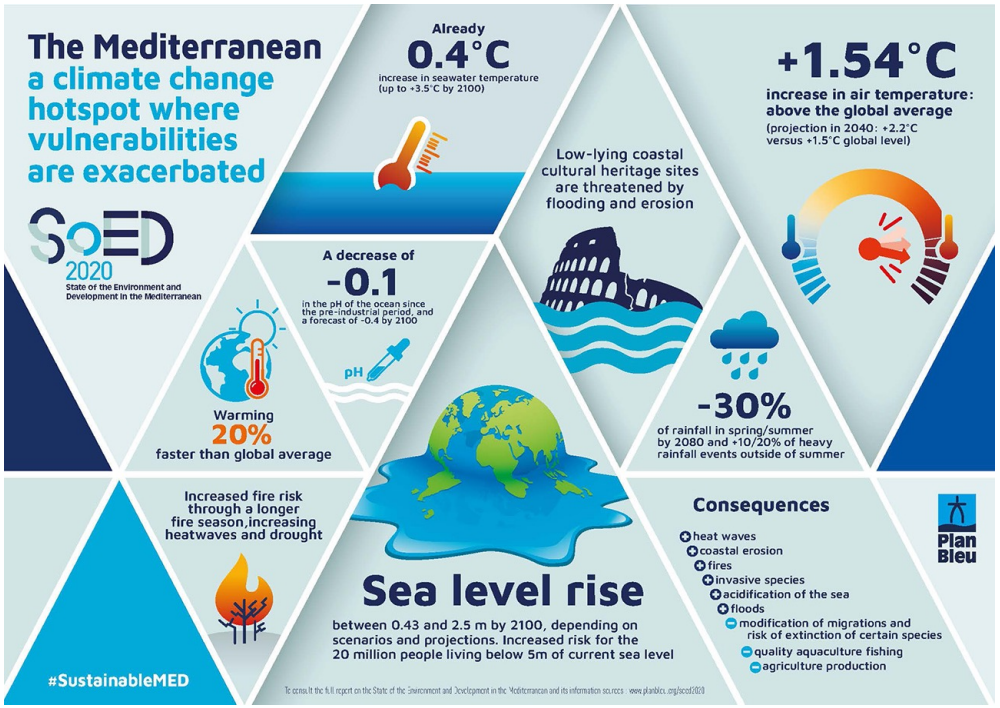
Sustainable wood-based construction in SUDOE





Sustainable wood-based construction in SUDOE





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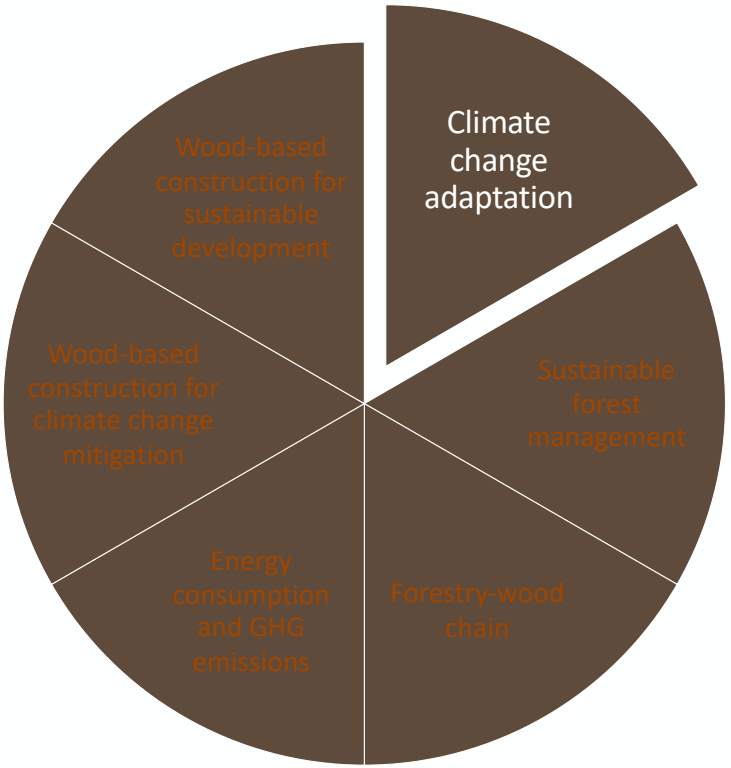
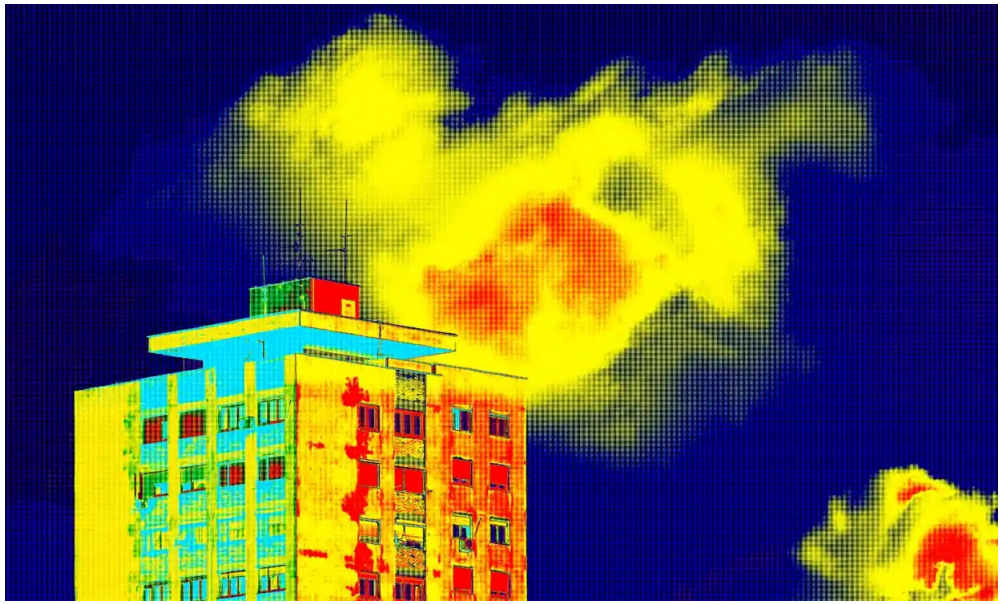
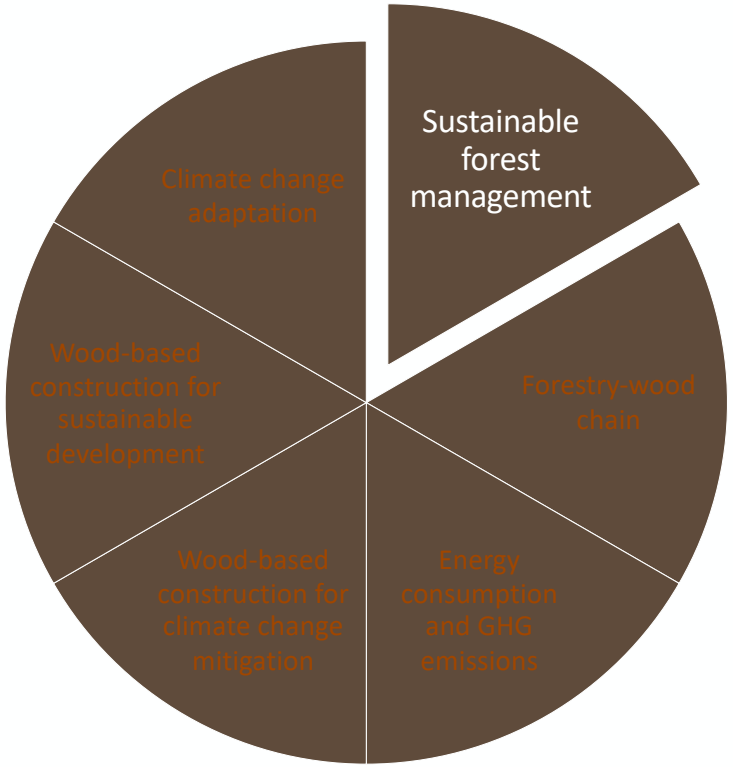




1st challenge: - Temperature increases and prolonged droughts are consequences of climate change in SUDOE.
- Buildings are not well adapted (energy inefficiency and non-insulating materials).

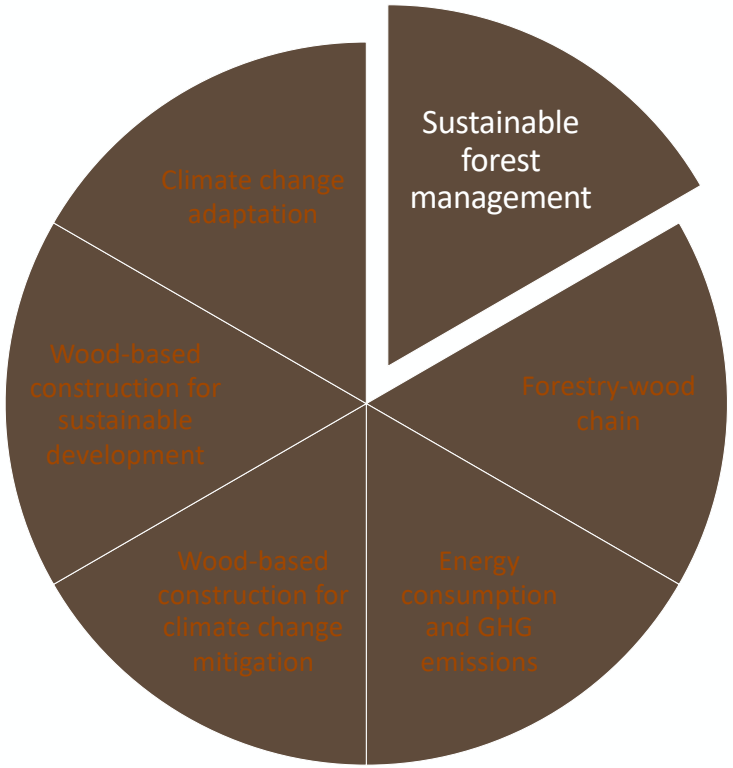
Sustainable wood-based construction in SUDOE



Hans Carl von Carlowitz 1713: *Sylvicultura Oeconomica*
Forest Sustainability Principle

"For the protection and cultivation of wood, a lot of art, science and effort are required to ensure a continuous, permanent and sustained use (NACHHALTIGKEIT) […].
When forests are ruined, income is lost for many years (50-100) ruining the treasury, leading to an acceptable short-term profit masking a loss that cannot be replaced."

Sustainable wood-based construction in SUDOE



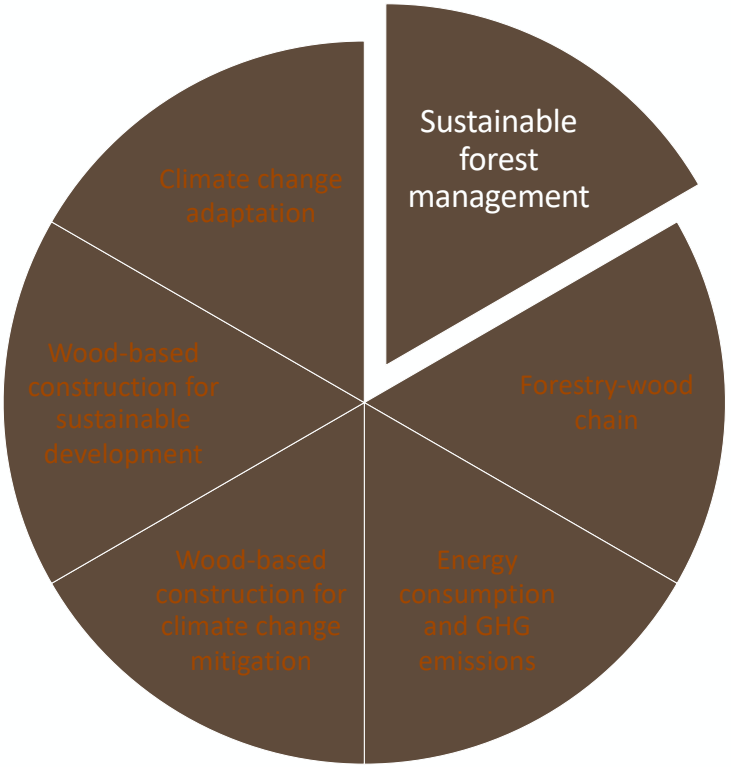
SUSTAINABLE FOREST MANAGEMENT

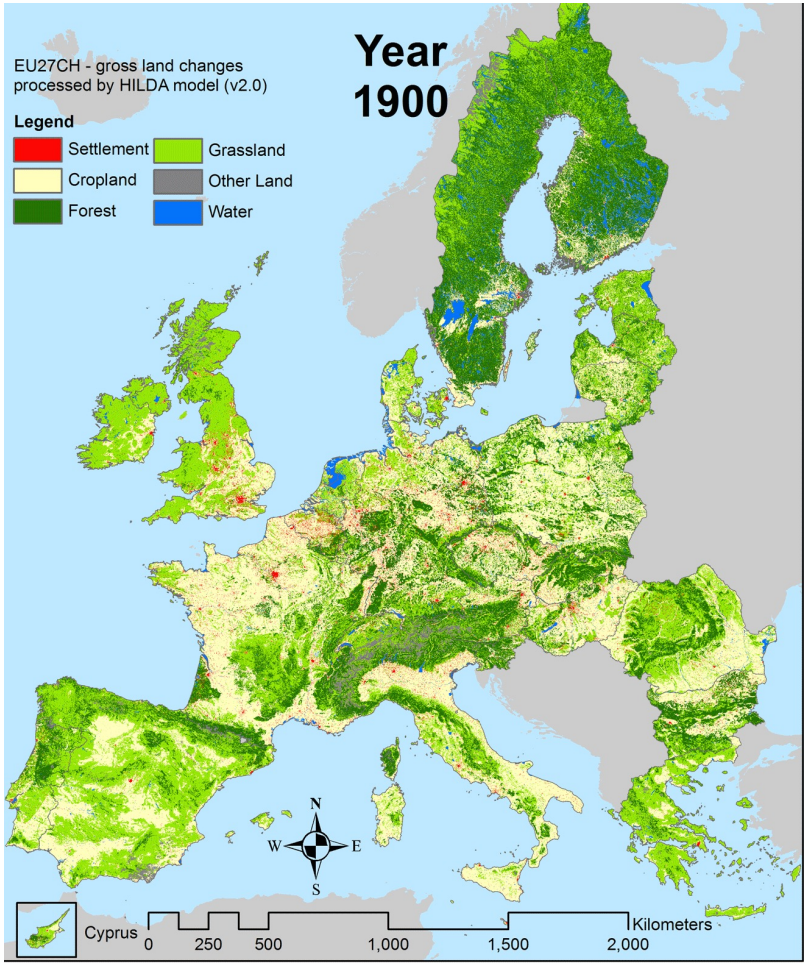
TODAY's DEFINITION

Sustainable Forest Management means the stewardship and use of forests and forest lands in such a way, and at a rate, that maintain their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfil, now and in the future, relevant ecological, economic and social functions, at local, national, and global levels, and that does not cause damage to other ecosystems.

Source: EEA Glossary 2023

Sustainable wood-based construction in SUDOE





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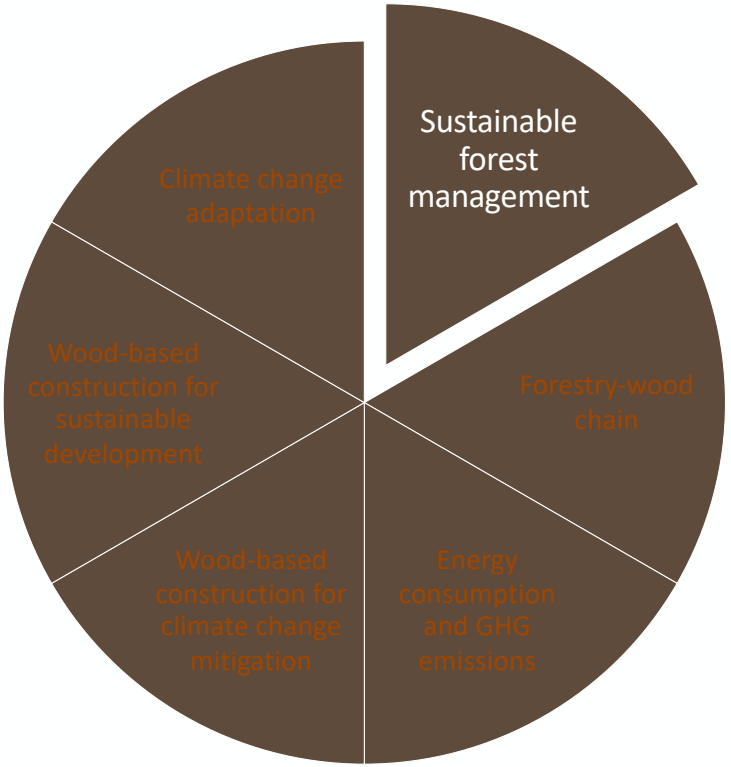
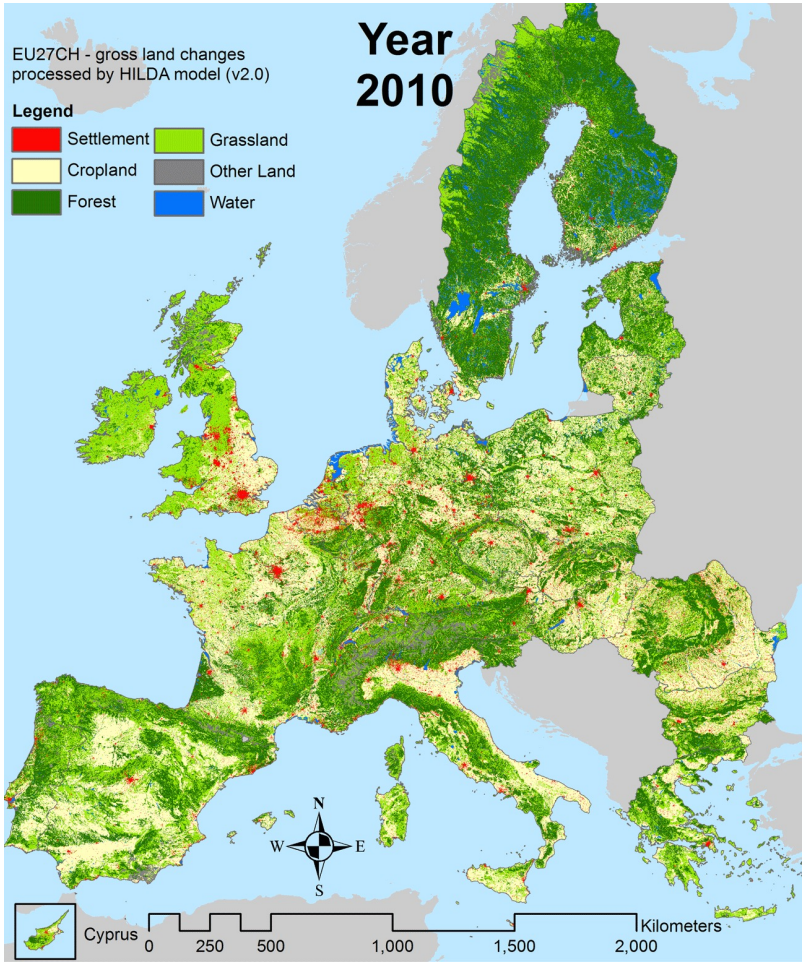
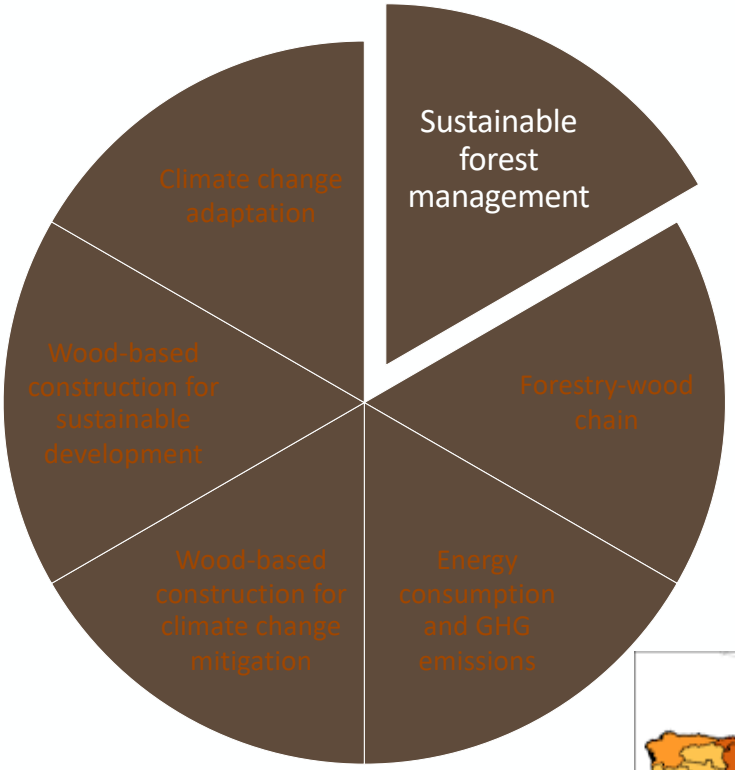
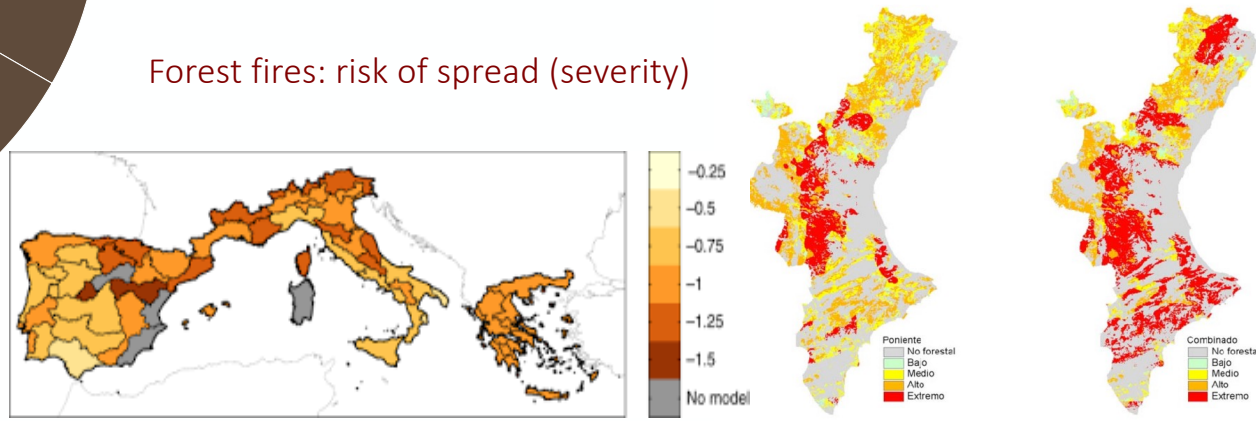




Sustainable wood-based construction in SUDOE



Forest fires: risk of spread (severity)



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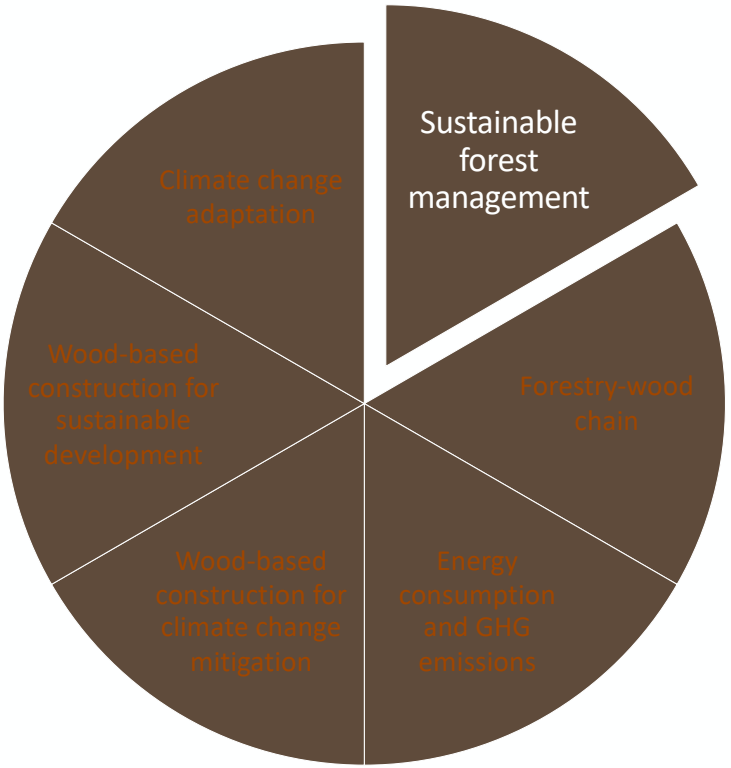

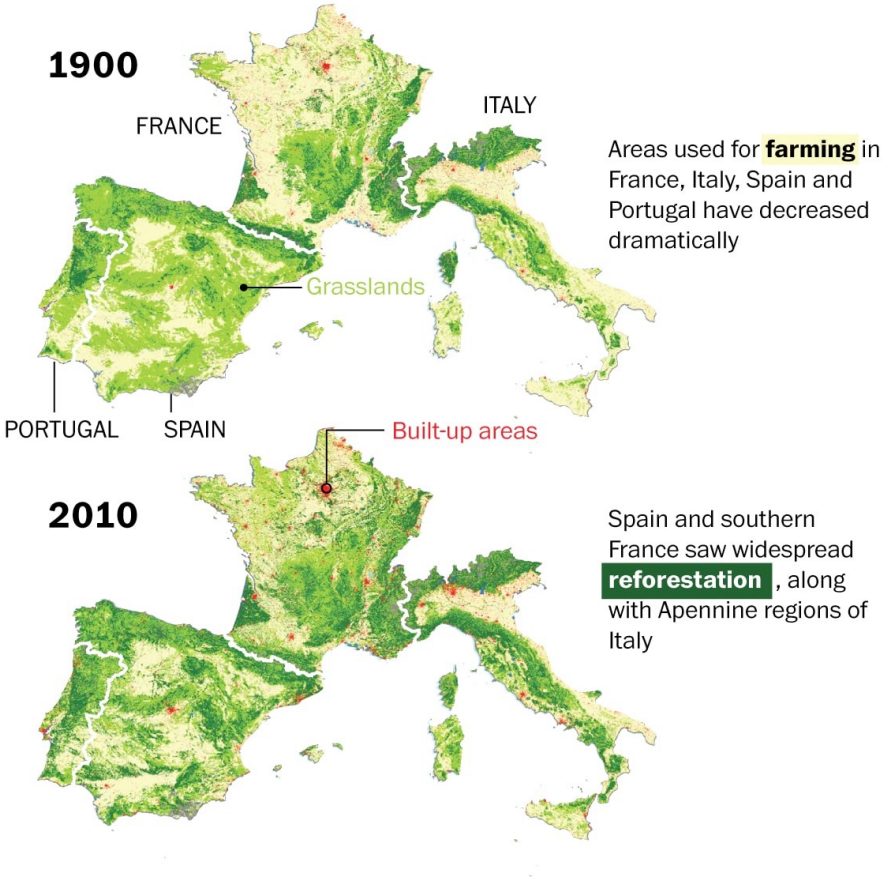

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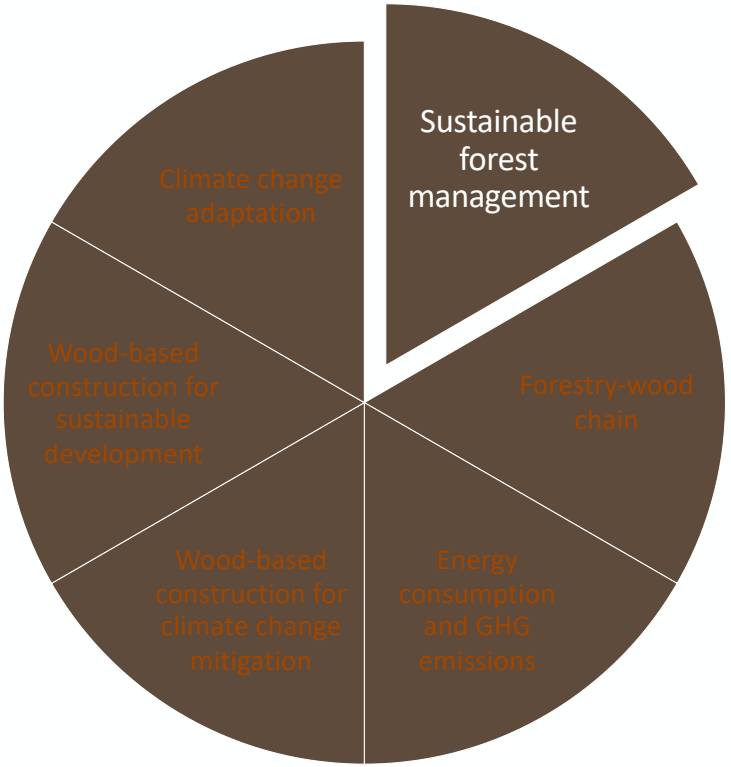
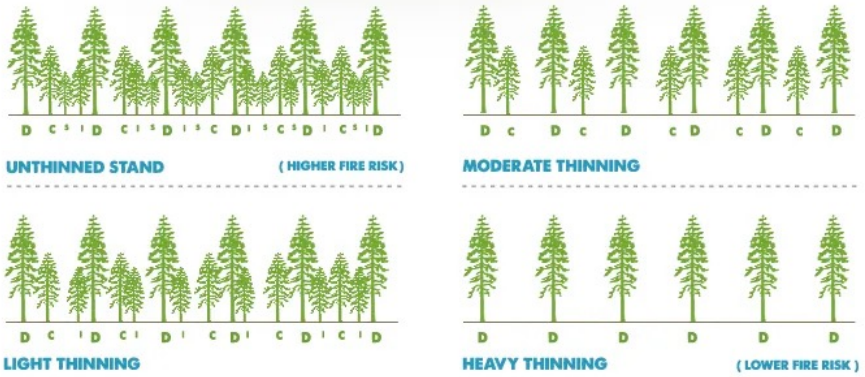


Intensive silvicuture towards timber production

Protective silvicuture towards ecosystem resilience and conservation



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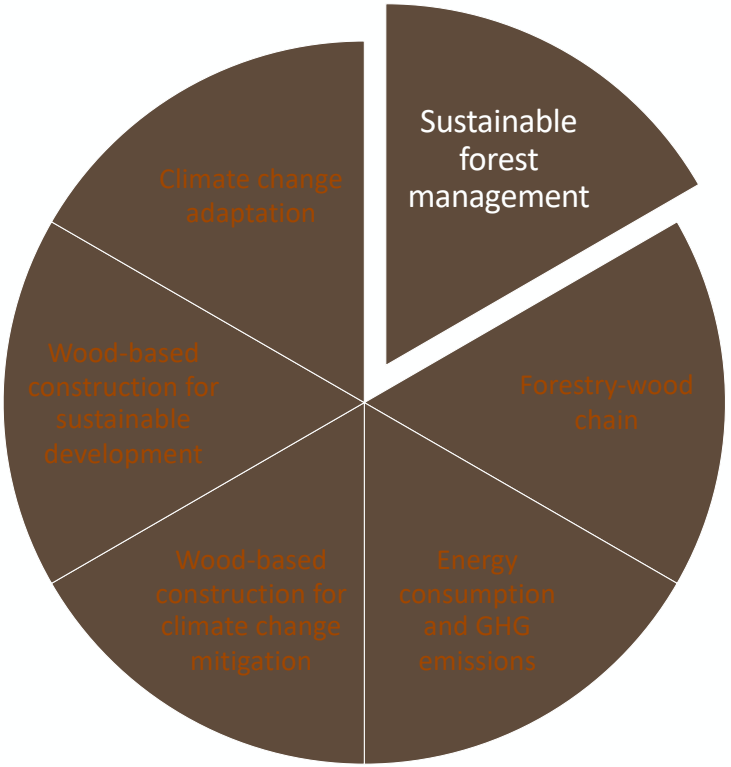
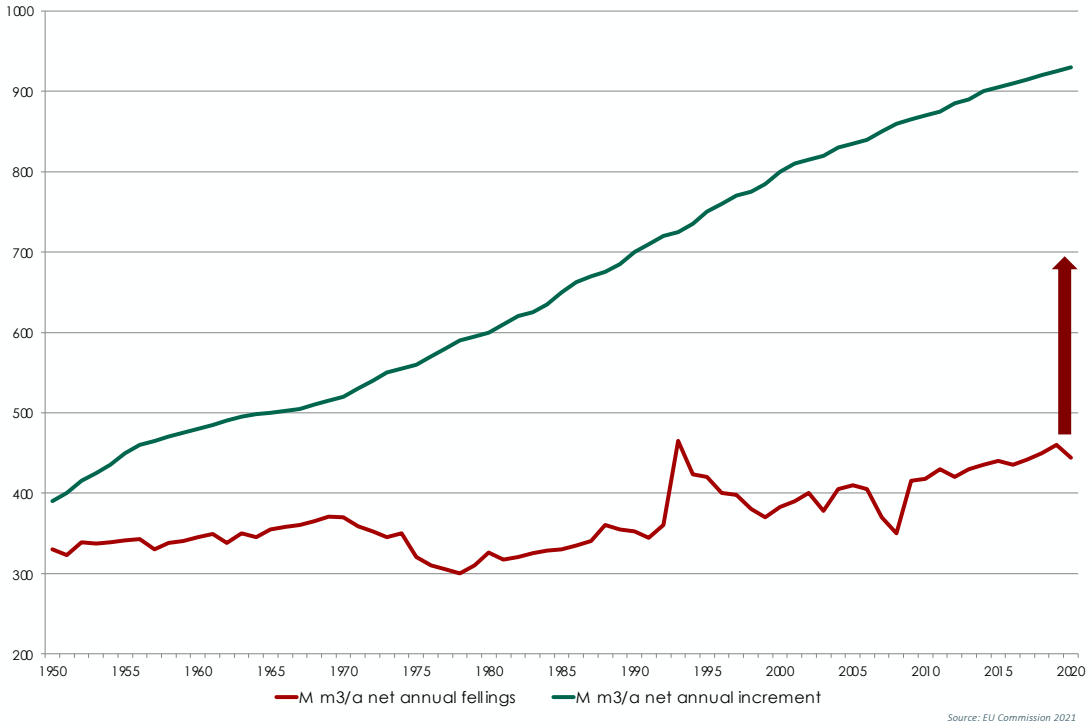


Sustainable room to maneuver in Europe?



Source: EU Commission 2021

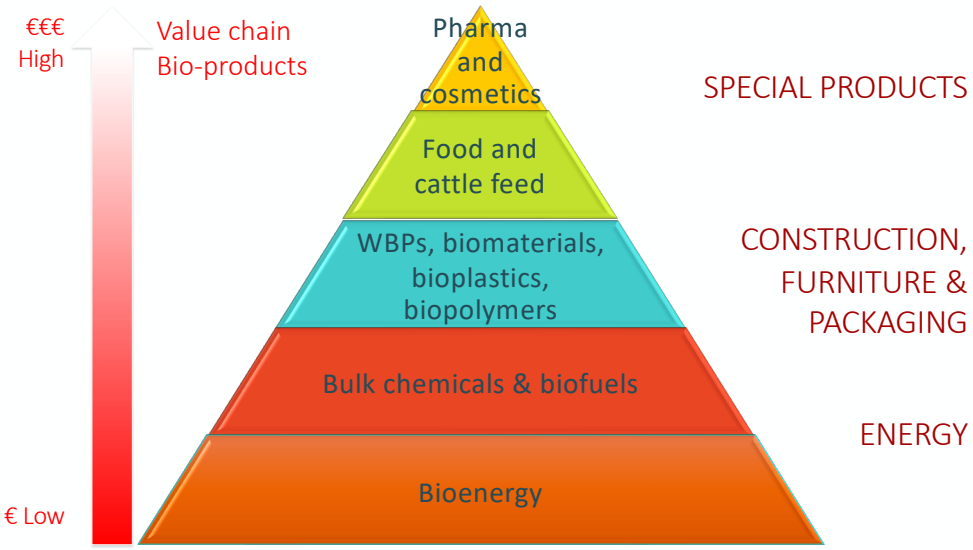
2nd challenge: - SFM necessary to preserve forest ecosystems against climate change (forest fires).
- Large SUDOE forests (pines): high tree density and low quality production (lack of management).

Sustainable wood-based construction in SUDOE

Forest-based circular bioeconomy

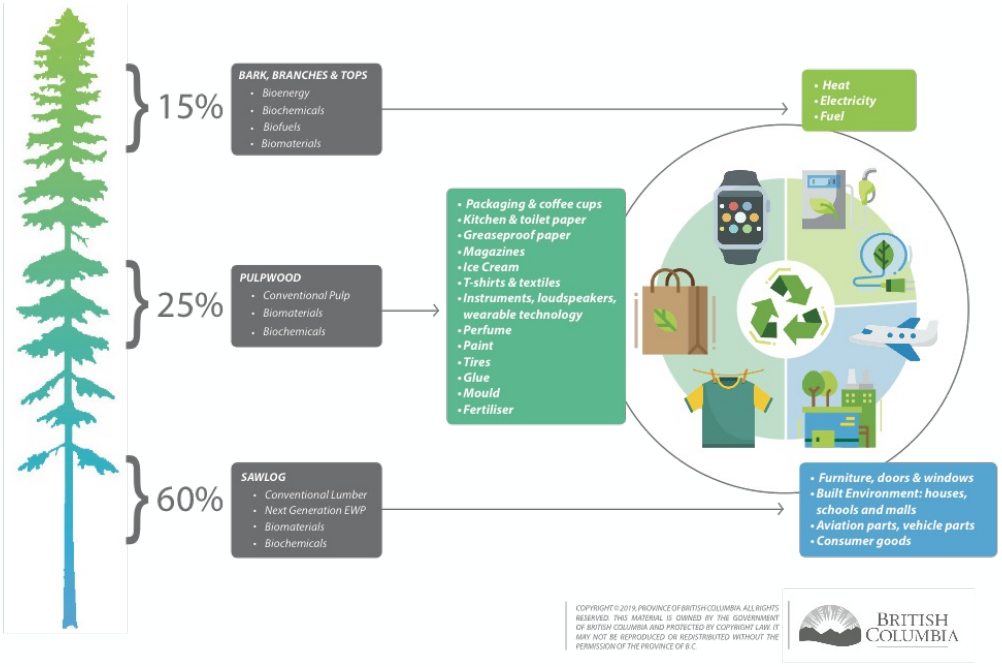
Sustainable wood-based construction in SUDOE

Forest bioeconomy: added value



Sustainable wood-based construction in SUDOE

Cascade use of wood



BRITISH COLUMBIA

Sustainable wood-based construction in SUDOE

Cascade use of wood

Biomass Ø<7cm

WBP Ø>7cm

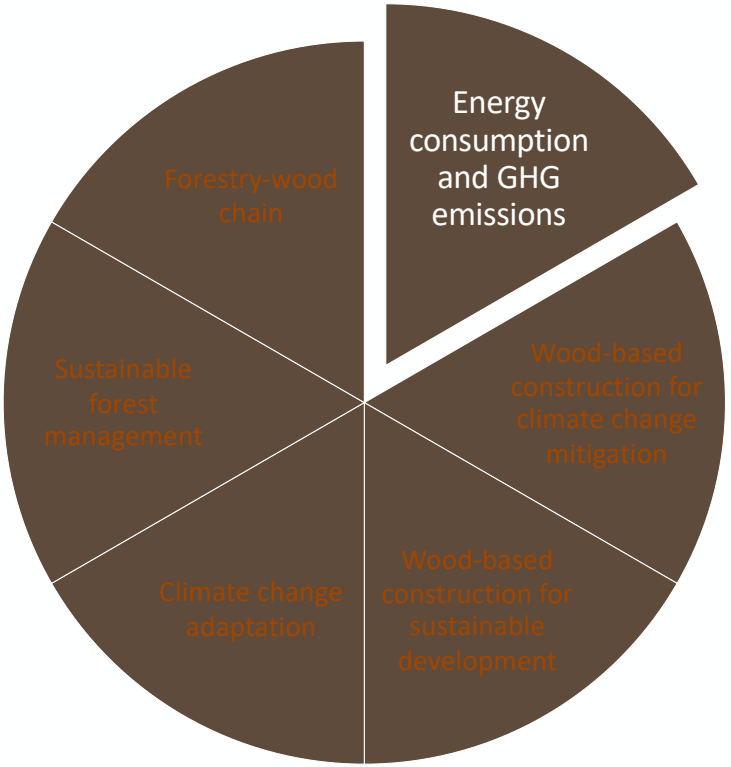
Sawn timber
- chipper canter Ø>20cm
- conventional Ø>30cm

Veneer Ø>30cm

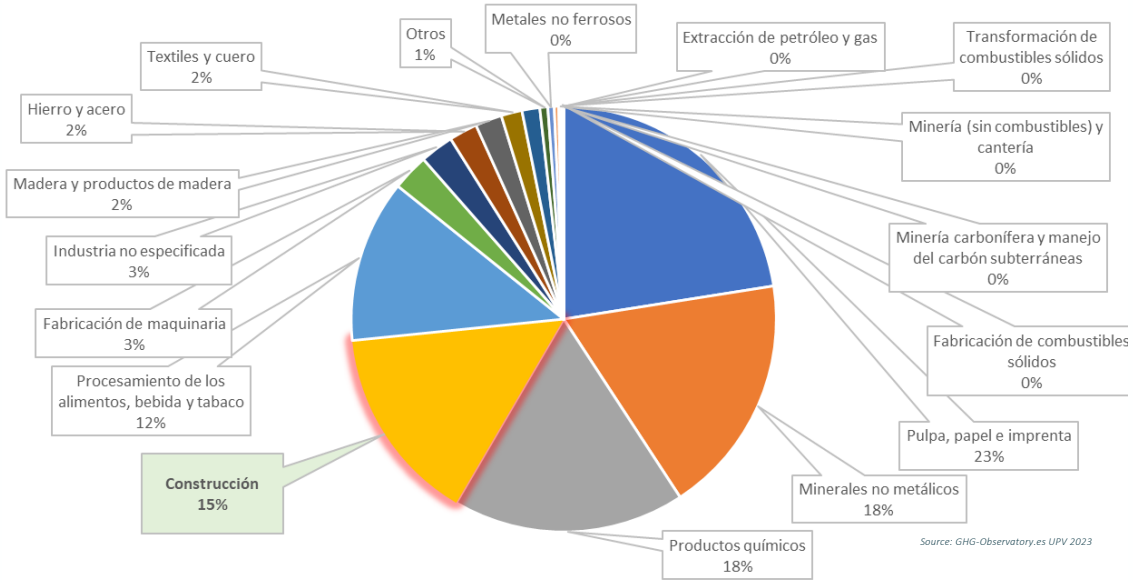
Sustainable wood-based construction in SUDOE

3rd challenge: - Local SUDOE sawmills are SMEs (pine sawn timber)
- Products: small dimension/low quality (packaging/pallets), and by-products (WBPs and bioenergy)

Sustainable wood-based construction in SUDOE



Emissions derived from energy use in industry (CV)



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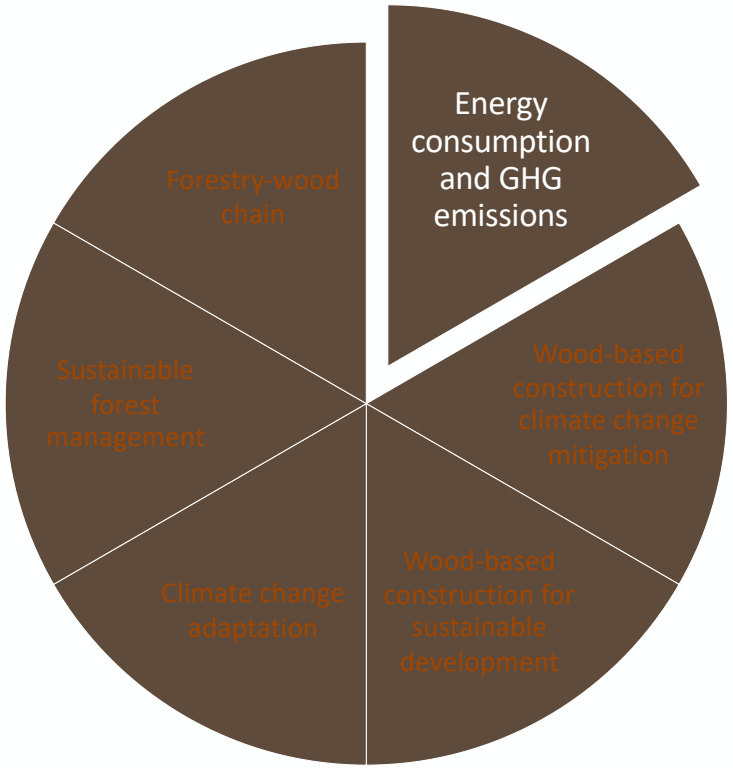
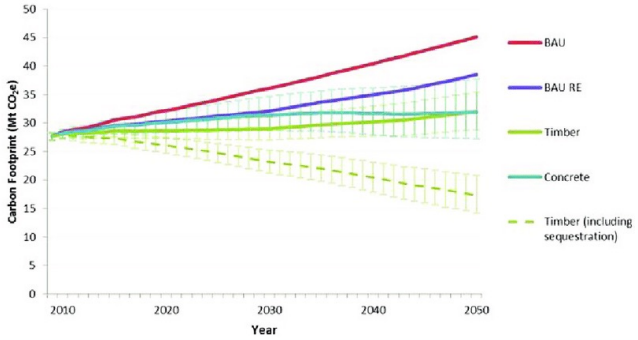
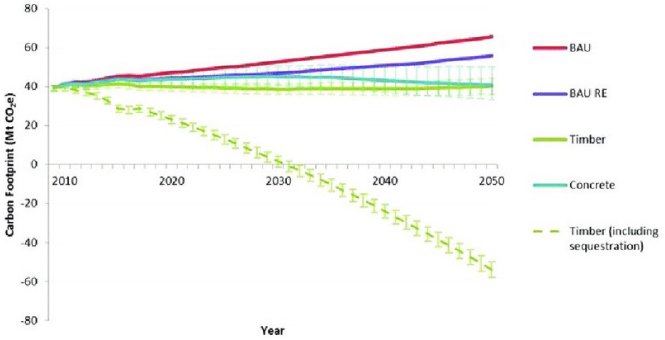


Total carbon footprint of commercial building sector AUS



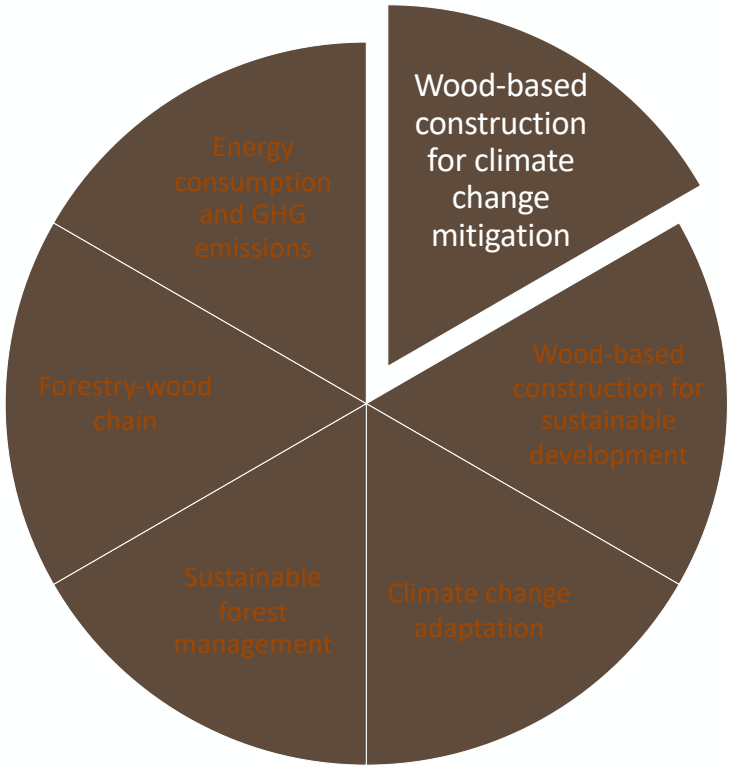
Total carbon footprint of residential building sector AUS



Source: Teh et al. 2017

4th challenge: - In Europe: the building sector is responsible of 40% of energy consumption, 35% of GHG emissions and 50% of extracted materials.

Sustainable wood-based construction in SUDOE



REDUCING THE EFFECTS OF CLIMATE CHANGE IN THE CONSTRUCTION INDUSTRY

There are a number of measures businesses & companies within the construction industry can take to try reduce the impact on climate change from the construction industry.

REDUCE BUILDINGS CARBON FOOTPRINT: Many companies are implementing steps to reduce their own (& the buildings they construct) carbon footprint to minimise the impact of global warming.

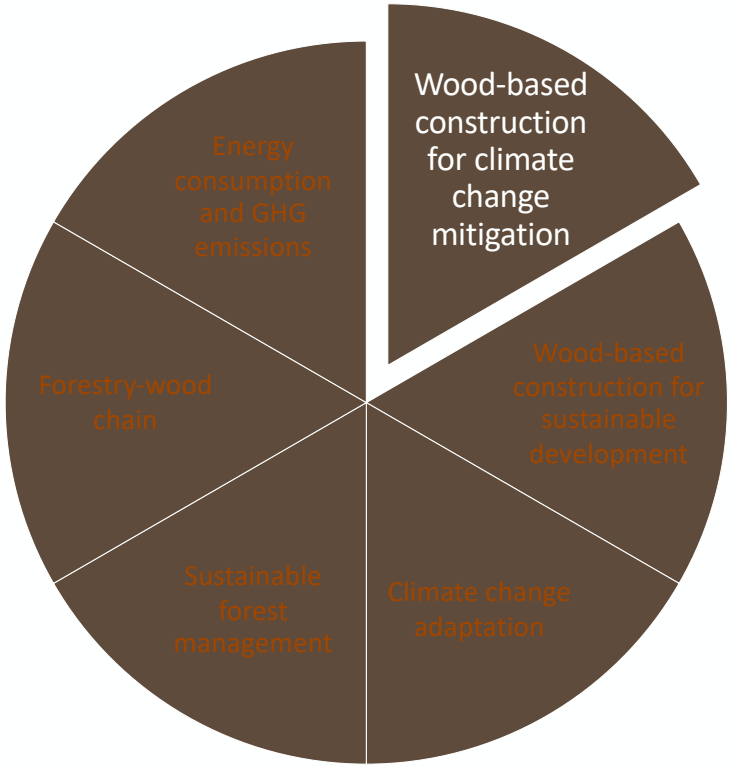
USING GREEN BUILDING MATERIALS: Builders are now using "green building' materials in place of traditional construction materials which produce a lot of carbon and other greenhouse gases in their production.

CREATING URBAN GREEN SPACE: Companies are leading the way in Australia to create urban greenery or living infrastructure throughout cities.

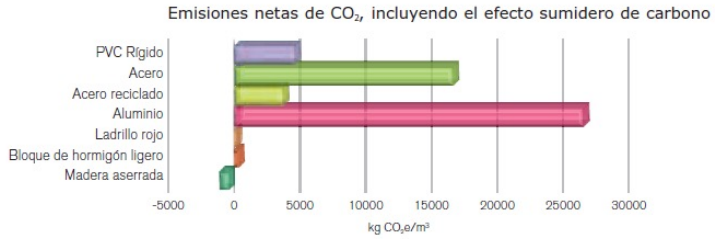
FUTURE PROOFING BUILDINGS & INFRASTRUCTURES: We need to ensure that the projects we create have plans for future conditions.

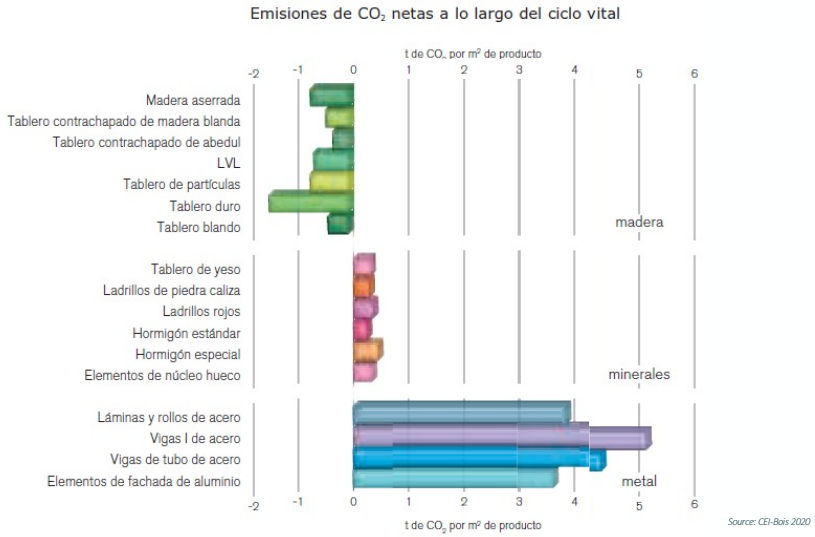
Source: Hunter 2023

Sustainable wood-based construction in SUDOE



BUILDING WITH WOOD: TACKLING CLIMATE CHANGE





Source: CEI-Bois 2020

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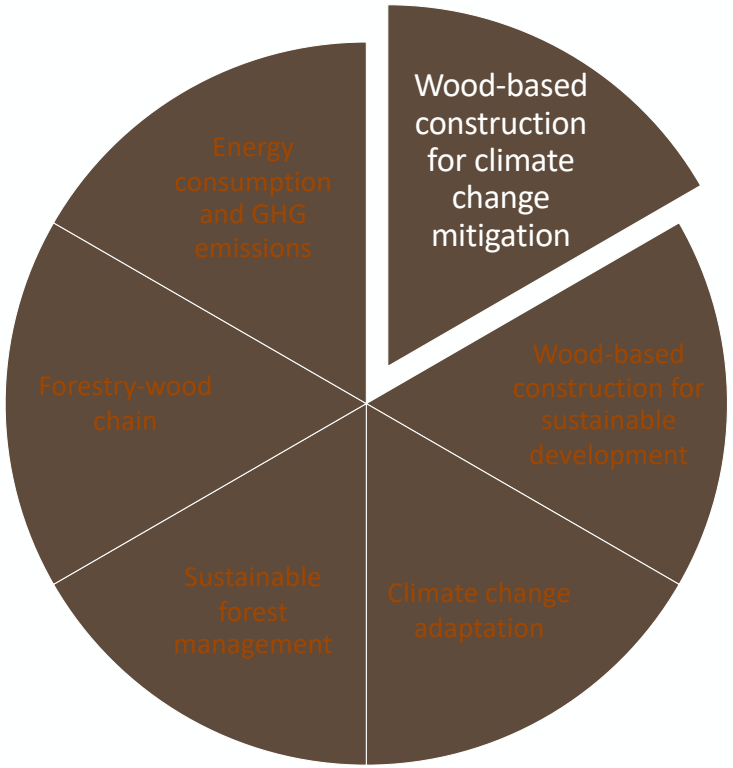
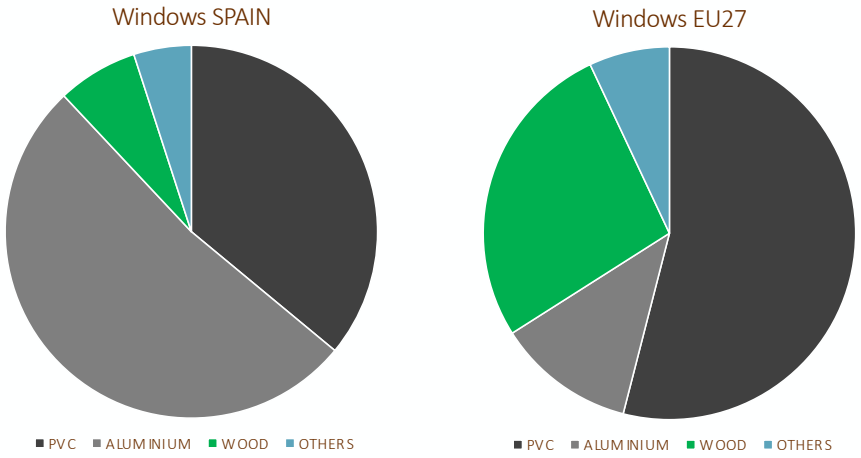


Wood installed in long-life products (buildings):

Europa: 60 Mt C

SUDOE: > 10 Mt C

Wood in windows:



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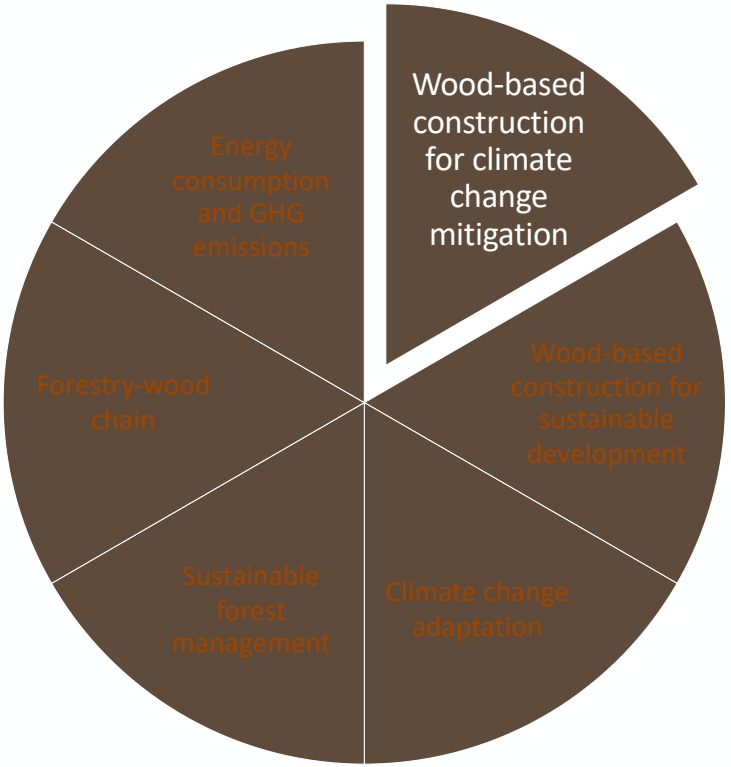

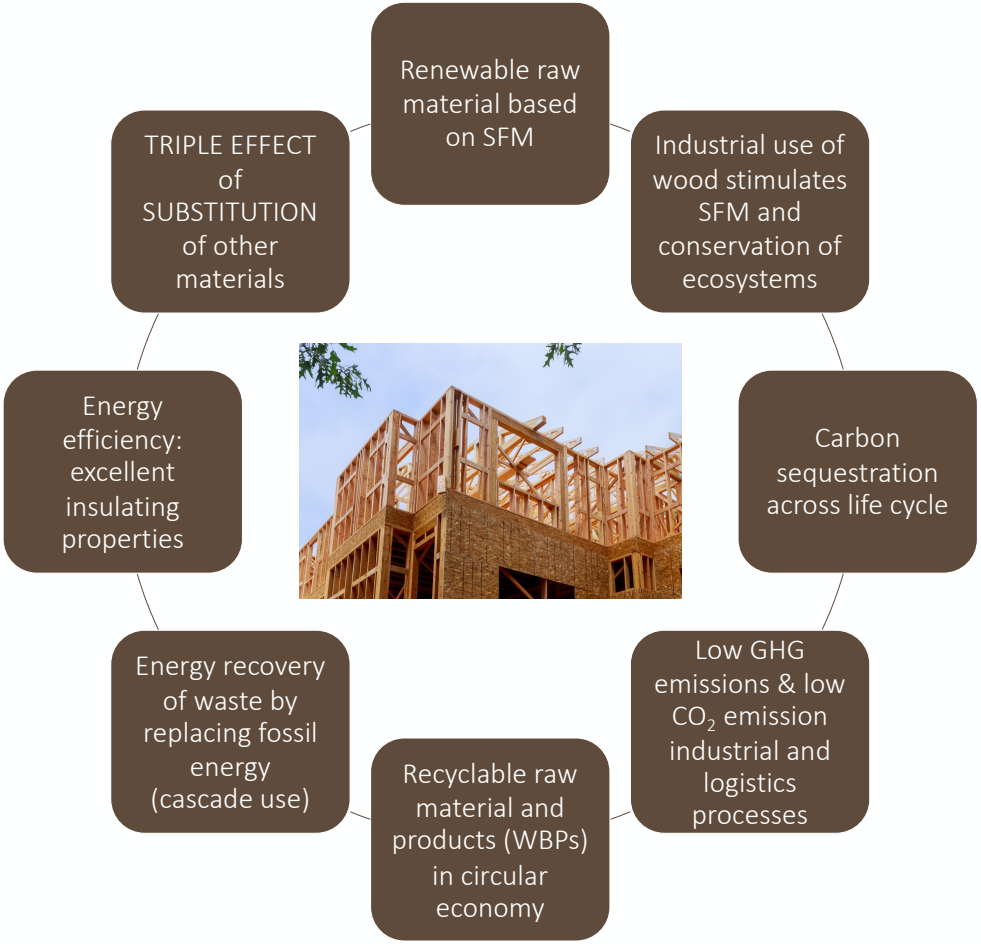

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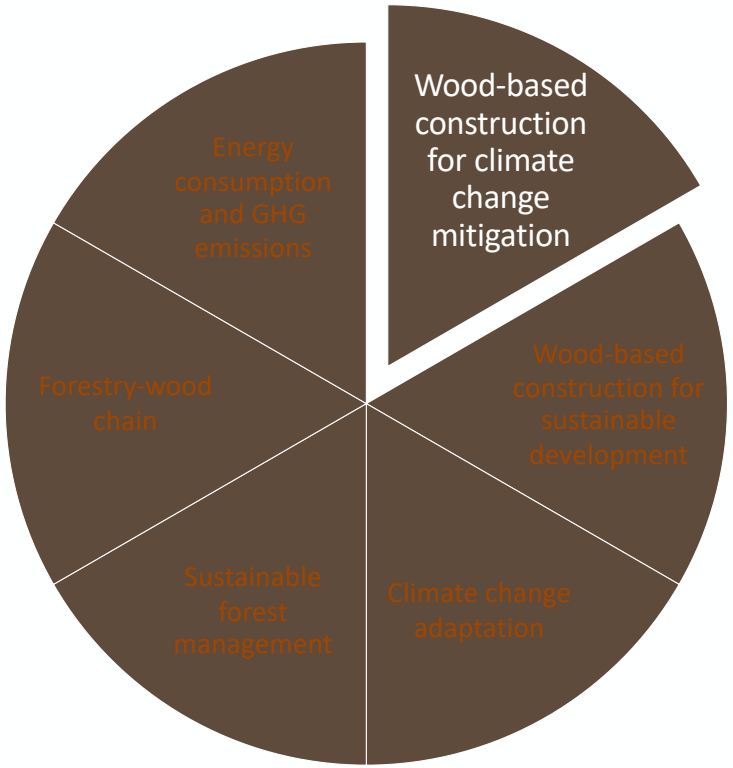
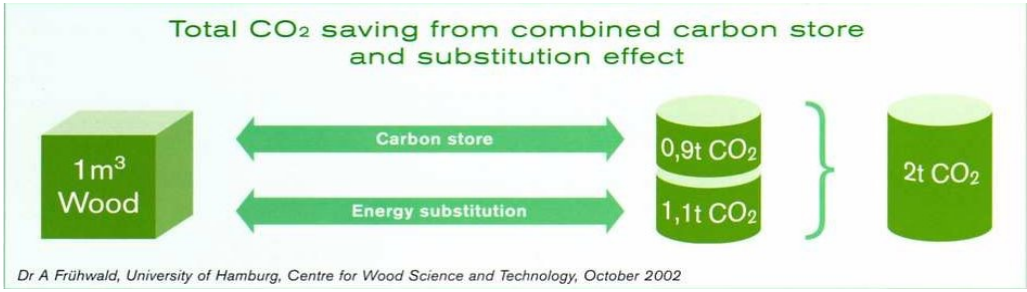


TRIPLE EFFECT OF SUBSTITUTION of other materials:

Replacing materials with high CO_2 emissions (plastics, steel, aluminium, concrete...)

I. reduction of emissions in production and logistics processes,
II. increased recycling rate,
III. and longer carbon sequestration lengthening of product life cycles.



5th challenge: - Construction systems with traditional materials: high carbon footprint and energy requirements.
- Wood-based construction is an optimal solution to face the reduction of GHG emissions.

Sustainable wood-based construction in SUDOE

TRENDS IN WOOD CONSTRUCTION IN EUROPE

Current situation and forecast: continued and sustained increase in construction activity in Europe, more accentuated in rehabilitation, public and civil building than in new residential construction.

Wood continues to increase its market share, both in structural elements and in joinery: doors, windows, flooring, cladding, outdoor.

Sustainable wood-based construction in SUDOE

VENEER products for construction

PLYWOOD

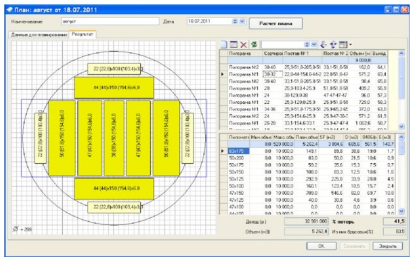
LVL - MICROLAM

PSL - PARALLAM

I-JOISTS

Sustainable wood-based construction in SUDOE

LARGE SAWN TIMBER products for construction



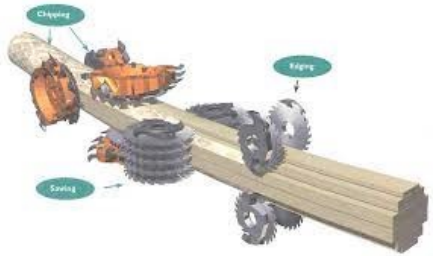
PLANKS (>50mm)

BOARDS (<50mm)

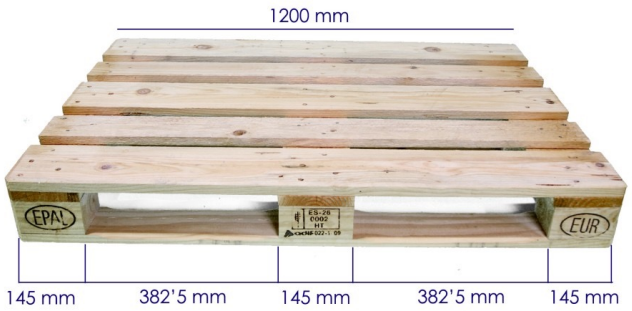
Strength properties / Class		C14	C16	C18	C20	C22	C24	C27	C30	C35	C40	C45	C50	
Bending	$f_{m,k}$	14	16	18	20	22	24	27	30	35	40	45	50	N/mm²
Tension parallel to grain	$f_{t,0,k}$	8	10	11	12	13	14	16	18	21	24	27	30	N/mm²
Tension perpendicular to grain	$f_{t,90,k}$	0,4	0,5	0,5	0,5	0,5	0,5	0,6	0,6	0,6	0,6	0,6	0,6	N/mm²
Compression parallel to grain	$f_{c,0,k}$	16	17	18	19	20	21	22	23	25	26	27	29	N/mm²
Compression perpendicular to grain	$f_{c,90,k}$	2	2,2	2,2	2,3	2,4	2,5	2,6	2,7	2,8	2,9	3,1	3,2	N/mm²
Shear	$f_{v,k}$	3	3,2	3,4	3,6	3,8	4	4	4	4	4	4	4	N/mm²
Mean MoE parallel to grain	$E_{0,mean}$	7000	8000	9000	9500	10000	11000	11500	12000	13000	14000	15000	16000	N/mm²
5th percentile MoE parallel to grain	$E_{0,05}$	4690	5360	6030	6365	6700	7370	7705	8040	8710	9380	10050	10720	N/mm²
Mean MoE perpendicular to grain	$E_{90,mean}$	233	267	300	317	333	367	383	400	433	467	500	533	N/mm²
Mean shear modulus	G_{mean}	438	500	563	594	625	688	719	750	813	875	938	1000	N/mm²
Characteristic density kg/m³	ρ_k	290	310	320	330	340	350	370	380	400	420	440	460	kg/m³
	ρ_{mean}	350	370	380	390	410	420	450	460	480	500	520	550	kg/m³

Sustainable wood-based construction in SUDOE

SMALL SAWN TIMBER products



PALLETS



Sustainable wood-based construction in SUDOE

SMALL SAWN TIMBER products: EWPs for construction

GLUELAM

CLT

Sustainable wood-based construction in SUDOE

WBPs products

CHIPBOARD

MDF

OSB

COMPOSITES

Sustainable wood-based construction in SUDOE

IMIP CHALLENGE:
USE OF SUDOE RESOURCES IN ADVANCED CONSTRUCTION

CLT

OSB

EXPANDED DARK CORK PANELS

Pinus pinaster
Pinus halepensis
Pinus nigra
Pinus uncinata

Quercus suber

6th challenge: - Advanced construction systems based on SUDOE wood & cork could replaces traditional ones, generating technic, environmental and socio-economic advantages.

IMIP project

SUDOE IMIP

Objectives

Results

Working Packages

- WP1
- WP2
- WP3
- WP4
- WP5
- WP6
- WP.T1
- WP.T2
- WP.T3

IMIP project

- SUDOE IMIP
  - Objectives
  - Results
  - Working Packages
    - WP1
    - WP2
    - WP3
    - WP4
    - WP5
    - WP6
    - WP.T1
    - WP.T2
    - WP.T3

IMIP

Innovative Eco-Construction System Based on Interlocking Modular Insulation Wood & Cork-Based Panels

IMIP project

SUDOE IMIP

- Objectives
- Results
- Working Packages
  - WP1
  - WP2
  - WP3
  - WP4
  - WP5
  - WP6
  - WP.T1
  - WP.T2
  - WP.T3

TEAM

IMIP project

Low-carbon economy

Programme specific objective

To improve energy efficiency policies in public buildings and homes through the implementation of networks and joint experimentation.

Project main objective

To support the change towards a low carbon economy using bioproducts (wood & cork) for smart, sustainable, and inclusive growth with a special focus on the public construction sector.

Specific objectives

To design, validate and implement a new ecological construction system to improve energy efficiency in public buildings. *Operative objectives* are:

- To design an ecological construction system based on innovative wood & cork products supporting a low carbon economy,
- To test materials and products,
- To develop advanced ICTs for design, modelling, and evaluation of potential construction solutions,
- To compare the modular and interconnected insulating panels designed with currently used construction systems,
- To disseminate results and to train prescribers.

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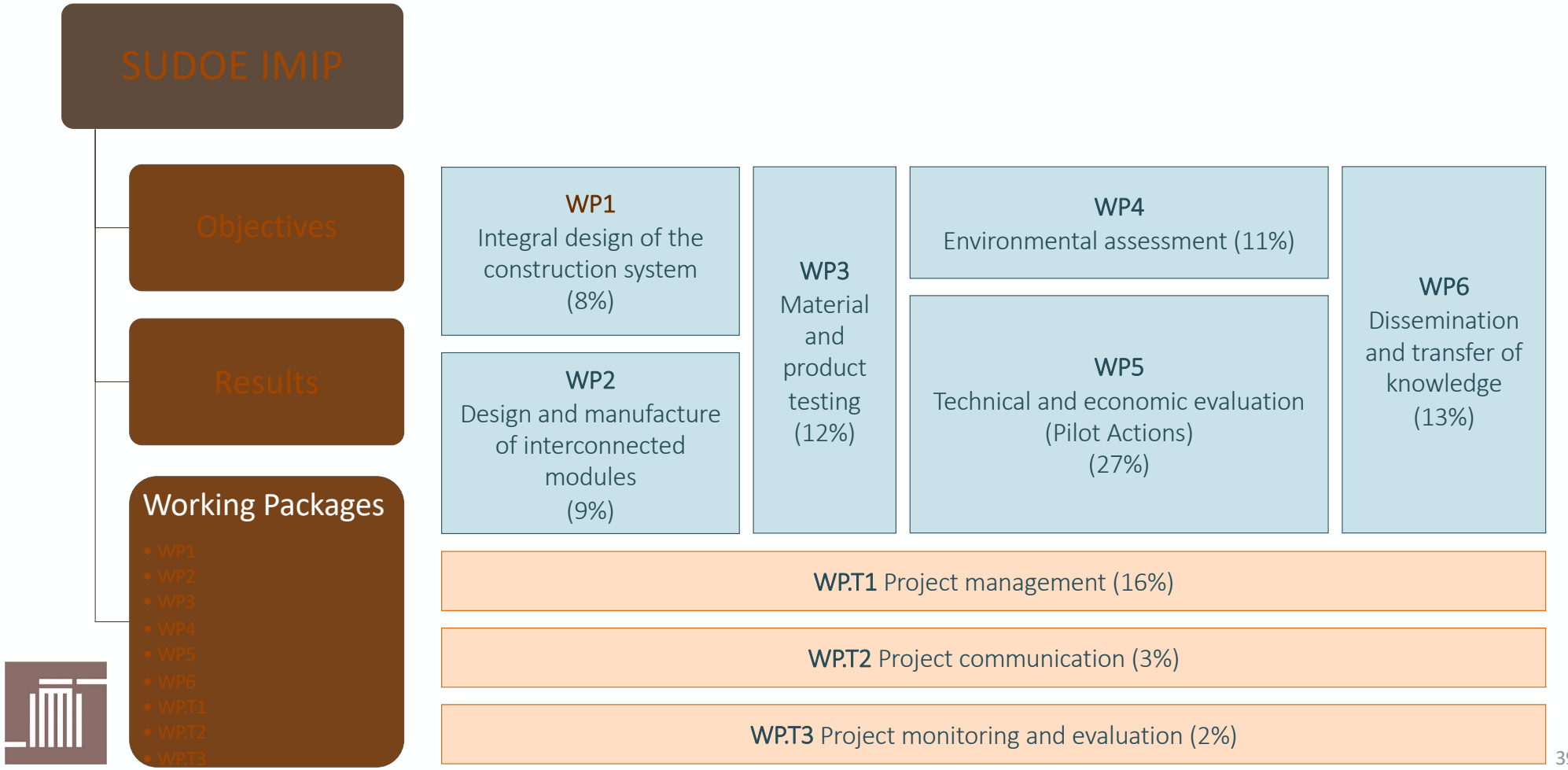
Programme result indicator

Representative and multidisciplinary key actors in the building and energy efficiency sector participating in a transnational cooperation project

Project results

1. An interconnected modular system of insulating panels made of wood & cork to improve energy efficiency of buildings, including their entire life cycle
2. A BIM plug-in to analyse the environmental benefits of the developed bioproducts used in construction (carbon storage and substitution effect)

IMIP project



IMIP project

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WP1
Integral design of the construction system

Activity	Partners
A.1.1 Analysis of autochthonous wood (*Pinus pinaster*, *P. halepensis*, *P. nigra*) and cork (*Quercus suber*) availability	**ISA** FCBA, UPV
A.1.2 Integrated forest harvesting systems and certification of traceability in the forest-industry harvest chain	**ISA** FCBA, UPV
A.1.3 Analysis of current uses of wood and cork in the Sudoe space	**ISA** INIA, AITIM
A.1.4 Sustainability analysis (triple balance)	**INIA** ISA
A.1.5 Definition of the technical and environmental quality requirements of the renewable raw material	AITIM

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WP2
Design and manufacture of interconnected modules

Activity	Partners
A.2.1 Interlocking panels design	UPV / AITIM
A.2.2 Preliminary analysis of existing compatible construction systems	INIA
A.2.3 Future potential uses of disassembled parts	INIA
A.2.4 Manufacture of interconnected panel prototypes	AITIM / UPV

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WP3
Material and product testing

Activity	Partners
A.3.1 Structural analysis	INIA
A.3.2 Acoustic isolation analysis	FCBA
A.3.3 Thermal isolation analysis	FCBA
A.3.4 Reaction to fire analysis	FCBA
A.3.5 Durability and dimensional stability analysis for external uses	AITIM

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WP4
Environmental assessment
ICT integration and evaluation of climate change mitigation

Activity	Partners
A.4.1 Development of a plug-in for BIM to evaluate energy efficiency and to estimate climate change mitigation effect on wood & cork construction elements	UPV
A.4.2 Quantification of the carbon sink and substitution effect	AAE
A.4.3 Life Cycle Analysis (harvest, transport, first and second transformation, use, disassembly and recycling)	IVE / UPC
A.4.4 Simulation of representative solutions by using virtual reality	UPV

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WP5

Technical and economic evaluation

Pilot actions in construction / rehabilitation of public buildings

Activity	Partners
A.5.1 Pilot action 1: Panel use in 4 representative public building projects in SUDOE (news or rehabilitated)	UPV / FCBA / ISA
A.5.2 Pilot action 2: Analysis of energy efficiency improvement in pilot projects with current construction systems	UPV / FCBA / ISA

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WP6
Dissemination and knowledge transfer

Activity	Partners
A.6.1 Analysis of barriers and drivers for the use of autochthonous wood & cork from SUDOE for construction and rehabilitation of public buildings	IVE / ISA
A.6.2 Roadmap for the implementation of solutions	AAE
A.6.3 Capitalization	UPC / Xylofutur

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WP.T1
Project management

Activity	Partners
AT.1.1 Structure, responsibilities and procedures for the administrative management and for daily project coordination	UPV
AT.1.2 Bodies created for political and technical decision-making of the project and its competences	UPV
AT.1.3 Internal communication of the partnership	UPV
AT.1.4 Internal organization for the elaboration of reports	UPV
AT.1.5 Financial management of the project	UPV

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WP.T2
Project communication

Activity		Partners
AT.2.1 Creation of the logo		Xylofutur
AT.2.2 Website		Xylofutur
AT.2.3 Results diffusion event		UPC
AT.2.4 Poster with project information (UE Regulation 1303/2013)		Xylofutur

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WP.T3
Project monitoring and evaluation

Activity	Partners
AT.3.1 Structure, responsibilities and procedure for project monitoring	UPV
AT.3.2 Structure, responsibilities and procedure for project evaluation	UPV
AT.3.3 Indicate whether the monitoring and evaluation will be carried out internally or externally and the period of completion	UPV
AT.3.4 Foreseen procedures for risk management and quality control	UPV

Final dissemination event

Innovative Eco-Construction System Based on Interlocking Modular Insulation Wood & Cork-Based Panels

(IMIP)

Prof. Dr. José Vicente Oliver
Project Coordinator
joolvil@upv.es

Sevilla, 18/04/2023