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TRENDS IN THE DEVELOPMENT OF INNOVATIVE TIMBER PRODUCTS ON THE CONSTRUCTION MARKET IN EUROPE

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ABSTRACT: Extending the existing knowledge of timber construction to new design challenges (multi-storey buildings, complex shaped structures, design for disassembly, resource efficiency, sustainability or affordability, among others) requires innovation. This work aims to analyse the trends in the development of innovative timber products and systems on the market for the timber construction sector. To this end, a descriptive statistical analysis of construction products regulated by the EU's *Construction Products Regulation* (CPR) was carried out. Both, mature products with CE marking developed under harmonised standards of the *European Standardisation Committee* (CEN), and innovative products with European Technical Assessment (ETA) certification obtained on the basis of *European Assessment Documents* (EAD) of the *European Organisation for Technical Assessment* (EOTA), were included. The results show a trend towards diversification in both softwood and hardwood species for structural applications, and an increase trend in sawnwood and wood-based panels production, mainly from softwoods. Innovative products with ETA certification also show an increasing trend since 2015, produced in Europe and internationally. Most of these are connector for structural applications, building kits, structural wood products and thermal insulation materials.

KEYWORDS: EOTA-EAD-ETA, CEN-TC-EN, notified bodies, standardisation, wood species

1 – INTRODUCTION

The construction sector is responsible for 36 % of energy consumption and for 39 % of global CO_2 emissions. 11% of CO_2 emissions globally come from construction embodied carbon and the other 28% are related to building operations like heating and cooling [1]. The construction sector consumes 50% of total global annual raw material consumption. A fourth of it is used in residential and commercial buildings [2]. In this category, concrete dominates the total stock of materials, representing over 90% of the total weight, whereas wood products used in construction account for only 1.4% in weight and 7% in volume of total construction materials. Global growth of emissions is driven by rapid urbanization, with about 5 billion m^2 of new floor area space added annually: the equivalent of building the size of Paris once a week, or Japan every year [3]. Current gross-accumulated floor area of 257 billion m^2 (residential and commercial) and annual construction material consumption is predicted to almost double by 2060: the equivalent of adding an entire New York City every month, for 40 years [4], [5]. The European construction market grows at a slower rate than the rest of the world. Annually new added floor area accounts for only 1% of existing building stock [6], [7]. Total floor area is expected to increase by 30% by 2050. Based on long-term averages, the overall annual building construction volume in the EU-27 totals 240 million m^2, or more than 2 million housing units: approx. 1 million flats and 0.9 million single-family houses completed annually [7].

Approximately 75% of all construction in Europe is residential. In the EU, concrete, aggregate materials (sand, gravel and crushed stone) and bricks make up 90% (by weight) of all materials used, while wood accounts for only 3% in mass or 13% in volume. Still, the share of wood construction products used in Europe is twice the share compared to the rest of the world. Europe is the leading producer and innovator of engineered wood products (EWP) [6]. About 70% of wood consumed in the EU is used in furnishings and construction [8], [9]. Figure 1 shows a recent Sankey diagram of wood flows in EU-27 by industry and market [10]. A main observation is that most of sawmill industry products, which mainly use raw material from domestic removals (wood harvested from European forests), are feeding into the construction sector (groups 15 and 16). Furthermore, a share of wood-based panels, which are manufactured from both raw materials and residues of the sawmill industry, are also used in the construction sector.

In Europe, wood has traditionally been used in single family buildings. Around 8-10% of single-family buildings have a wooden frame. It varies regionally from above 80% in the Nordic countries to near zero in several southern European countries [7]. Innovations in EWP led to the use of wood in new types of buildings, such as in

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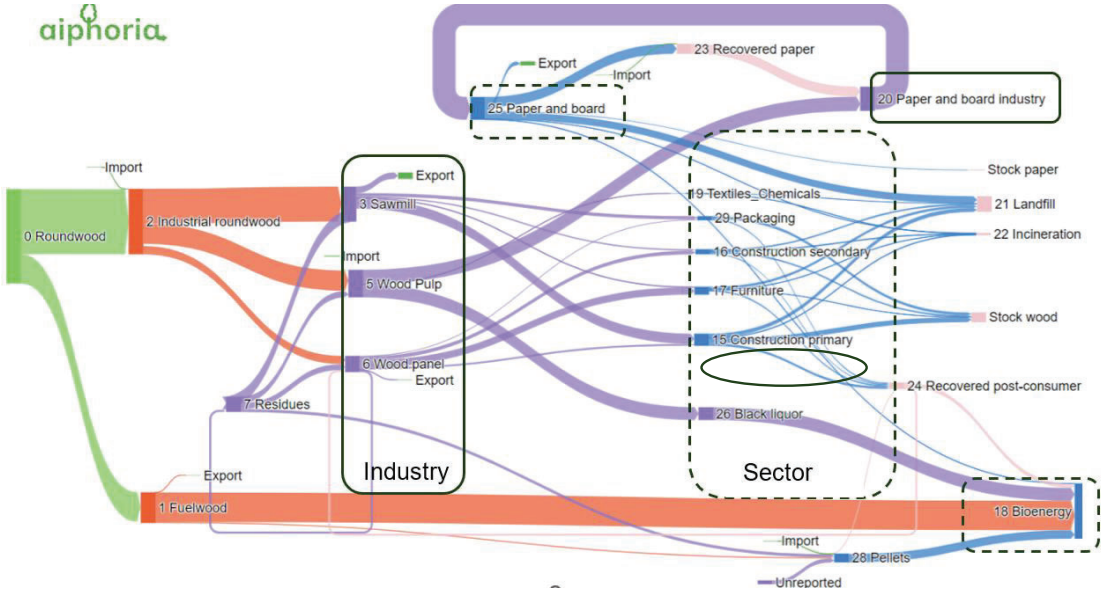

Figure 1. Sankey diagram of wood flow in EU-27 by industry and market in 2021. Adapted from [10]

the case of glued laminated timber (glulam) for long-span structures, which became more common from 1960s

onwards. The flexibility of glulam to manufacture large beams and different shapes, combined with the advantage of the high strength-to-weight ratio of wood, led to a trend of horizontal growth of structures in sports halls, warehouses, etc. More recently, cross-laminated timber (CLT) has enabled a growing trend of vertical timber structures in multistorey timber buildings [11]. Furthermore, wood construction is recognized as a key lever for the decarbonization of the built environment and the support of more sustainable forest management, leading several EU countries to set ambitious wood building targets and to begin a revision of national building codes [7], [9].

Nevertheless, a main challenge is to advance the existing, rich knowledge in timber construction towards the design of increasingly complex structures in multistorey building, aligned with criteria of resource efficiency and affordability. Technical innovation has become a main driver to meet the requirements and challenges of new timber buildings.

The objective of this study is to examine the wood construction market in Europe, to categorize existing types of products, and to analyse the trends in mature and emerging innovative products and systems for the timber construction sector, which are regulated by the Construction Products Regulation (CPR) [12]. According to the CPR, products must obtain the CE marking to be commercialized within the European Economic Area (EEA), to ensure that the products have been assessed for meeting high safety, performance and environmental protection requirements.

2 – METHODOLOGY

2.1 Global and EU consumption of construction materials

The study is based on a literature review of existing reports, documents and statistics referring to material consumption in construction of residential and commercial buildings, including both global [2], [13], [14], [15], [16] and European sources [6], [8], [9], [15], [17], [18], [19]. Results for annual consumption of construction materials in residential and commercial buildings and wood consumption for construction are shown in Table 1, comparing percentage share of wood product by mass and volume. Material consumption was usually given in mass (tonnes), or in case of wood products in volume (m^3), therefore, conversion factors were applied for a feasible comparison of units. Conversion factors for transforming wood volume to mass = volume*500 kg/m^3 (average density of commonly used softwood). Conversion factor for transforming reinforced cement concrete mass into volume = mass / 2500 kg/m^3 (average density of reinforced concrete).

2.2 Mature and innovative wood products in the European construction market

The distinction between mature versus innovative wood products on the European market in this study is based on the two pathways to obtain the CE marking. The first entails the main pathway for obtaining the Declaration of Performance (DoP) according to the requirements of harmonised European Standards (hEN). These are regulated by the European Standardisation Committee (CEN) under the different *Technical Committees* (TC).

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The second pathway applies when hENs are not available for the product, in which case the DoP has to be obtained via a *European Technical Assessment* certificate (ETA), regulated by the *European Assessment Documents* (EAD) under the European Organisation of Technical Assessment (EOTA). Therefore, the study considers 'technically mature products' as those for which CE marking can be obtained using the requirements of hEN of CEN, and 'innovative products' as those which followed the EOTA certification pathway to obtain the ETA. In this scope, clearly only innovative products at a high Technology Readiness Level (TRL) of 9 are considered, which have passed all R&D phases and are ready for market launch. All analyses presented in this paper are based on data from public databases.

Identification and production of mature wood products in Europe

Through a review of EN standards for wood products under the technical committees of CEN [20], the wood products were identified and sorted (Table 2). The strength-graded wood species per European country were identified, based on data provided by EN 1912 (CEN, 2023) (Table 3). Lasty, trends in production of mature products (sawnwood products and wood-based panels) were analysed based on FAOSTAT data [21] .

Identification and classification of innovative wood products on the European construction market

The list of innovative products was identified by analysing relevant ETAs in the EOTA database (EOTA 2024). Products are categorised by construction product area (PA) and by European Assessment Document (EAD), defining the general type and use of products included. The initial long list included 9,375 construction products with an ETA between 2013 and 2024, which was screened for relevant innovations for wood construction. The method applied involved a screening of ETAs for all the EADs under the product area (PA) focused on wood products (PA 13. Timber structures and PA 14. Wood based panels) and all the EADs under the remaining 34 PA. EADs were filtered using keywords such as 'wood', 'timber', 'lumber', or 'composite lightweight panel', allowing to identify 844 products from 9 PAs and 58 EADs. The unit of analysis is the product, i.e., the trade name and ETA number as identification. Various additional variables of the products were collected for the analysis (EAD Reference Number; generic product type and use; holder country; technical assessment body; version of product assessment; and date of the issue).

3 – RESULTS

3.1. State of the art on the consumption of construction materials

Table 1 presents the estimations of annual consumption of construction materials in EU and globally, the share for wood construction materials, and specifically for EWP. Current global annual consumption of construction materials for residential and commercial buildings is 25 Gt; [2], [13], [14]. The construction sector is the main consumer of sawnwood and wood-based panels, consuming 75% of the global production of sawnwood and wood-based panels [15]. It is estimated that around 360 million tones or 720 million m^3 of wood products were directly used by the global construction sector in 2018 and therefore requiring one third of total Round Wood Equivalent harvest (120 million m^3 RWE). In the EU, 70 Mm^3 or 70% of sawnwood is used for structural frames, carpentry, windows, flooring, decking, cladding, roofing, etc. and 23 Mm^3 or 39% of panel products are used in buildings [9], [19]. Wood represents 3% of total material mass use in European construction [8], [18] . Based on current modelling, EWP production capacity in Europe is 7,5 million m^3 or 4,5 million tones [6] . This capacity corresponds well to FAO statistics, which also include global EWP production data (however not yet up to date).

Table 1: Global and EU construction materials consumption

	Annual consumption of construction materials	Annual consumption of wood in construction	Share of EWP products in construction
Global	[1] **25 000 Mt^3** 10 000 Mm^3	[2] **360 Mt; 1.4%** 720 Mm^3; 7%	[3] **9 Mt; 0.04%** 15 Mm^3; 0.15%
EU	[4] **1 500 Mt** 600 Mm^3	[5] **46,5 Mt; 3%** 93 Mm^3; 13 %	[6] **4.5 Mt; 0.3%** 7.5 Mm^3; 1%

Notes: Mt: million tonnes; Mm^3: million cubic meters
[1][2],[13],[14]; [2][16]; [3][15]; [4][6],[17]; [5][18],[30],[8]; [6][6],[15]

3.2. Wood products regulated by CEN

Table 2 shows the wood products for construction regulated by EN standards under three CEN technical committees: TC 124 'Timber structures', TC 112 'Wood-based panels' (particleboards, fibreboards, OSB, plywood, solid wood panels), and TC 88 'Thermal insulating materials'. The technical committee of timber structures includes both strength-graded timber and roundwood and structural products such as GLT, CLT, LVL or prefabricated structural members. TC 112 of wood-based panels includes non-load-bearing panels and boards which are commonly used as envelopes and diaphragms. TC of thermal insulating materials applies not only to wood products, but any insulating material. However, there are three specific EN standards developed for wood and cork insulating products.

3.2.1. Strength graded structural timber in Europe

The first step for using sawnwood as a structural material or for manufacturing structural products, such as glulam or CLT, is its strength grading. The standard EN 1912 [23] collects the visual strength grades by wood species and country, and groups common strength classes, which define the physical and mechanical properties for the design of timber structures according to Eurocode 5. Table 3 identifies the strength-graded wood species in

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Europe according to this standard. As can be seen, most European countries count on strength graded wood for five European softwood species: fir, spruce, Sitka spruce, Scots pine and European larch. For most countries, these species were graded before the 1990s. The other European timber species, both softwood and hardwoods, were classified more recently and are only available in a few countries.

Historically, European countries which imported wood from outside Europe had developed wood grading requirements in their national standards for those species. Some examples are the UK or Ireland for softwoods imported from the USA and Canada, or the Netherlands for imported tropical hardwoods, which were mainly used for civil engineering applications, such as piles of harbours, because of their high natural durability [24]. Since 2016 exists a European standard with requirements for strength grading of imported tropical hardwoods (EN 16737, see Table 2).

3.2.2. Trends in production of sawnwood and wood-based panels globally and in Europe

Figure 2 shows the trends in global and EU-27 production of sawnwood and wood-based panels. Softwoods lead sawnwood production in both Europe and globally. However, the share of hardwoods in European production is considerably lower than in the global context. In 2023, the respective figures were 9% and 31%. Sawn softwoods show an increasing trend in production after the 2008 crisis and until 2021 in Europe, while hardwood production remained constant over the years. Most of the sawnwood is used for construction purposes [10]. From 2022, FAOSTAT provides also the estimated production of EWP for structural applications (GLT, CLT, LVL and I-joists). According to FAO, EWP in 2023 represented 1.5% (15 Mm^3 - globally) and 4.4% (7.5 Mm^3 - Europe) of the total sawnwood production, respectively. These values should be taken as a minimum estimation as the database is not completely accurate and

Table 2: Summary of mature products in Europe regulated by CEN

TC	EN	Product
124	14081/ **1912***	Strength graded structural timber with rectangular cross-section Assignment of visual grades and species
	16737	Visual strength grading of tropical hardwood
	15497	Structural finger-jointed timber
	14080	Glulam, GLT (softwoods)
	16351	Cross-Laminated Timber (CLT)
	14374	Laminated Veneer Lumber (LVL)
	14229	Wood poles for overhead lines
	14250	Prefabricated structural members assembled with punched metal plate fasteners
	14251	Structural round timber
	15228	Structural timber preservative treated against biological attack
112	309/ 312	Particleboards
	300	Oriented Strand Boards (OSB)
	316/ 622	Fibreboards: softboards, hardboards, medium boards (MDF)
	12369-1	OSB, particleboards and fibreboards used for structural design
	313	Plywood: - classified by surface appearance (softwoods and hardwoods) - for structural design (EN 12369-2)
	14279	Laminated Veneer Lumber (LVL)
		Wood-based panels: - wood veneer floor coverings (EN 14354) - melamine faced boards for interior uses (EN 14322) - for use in construction (13986) - floating floors (EN 13810) - flaxboards (EN 15197)
	13353/ 12775	Solid Wood Panels (SWP): - classified by surface appearance: softwoods and hardwoods (EN 13017) - for structural design (EN 12369-3)
	14755	Extruded particleboards
	634	Cement-bonded particleboards
88	13168	Factory made wood wool products
	13170	Factory made products of expanded cork
	13171	Factory made wood fibre (EN 13171)

TC 124: Timber structures; TC 112. Wood-based panels; TC 88. Thermal insulating materials

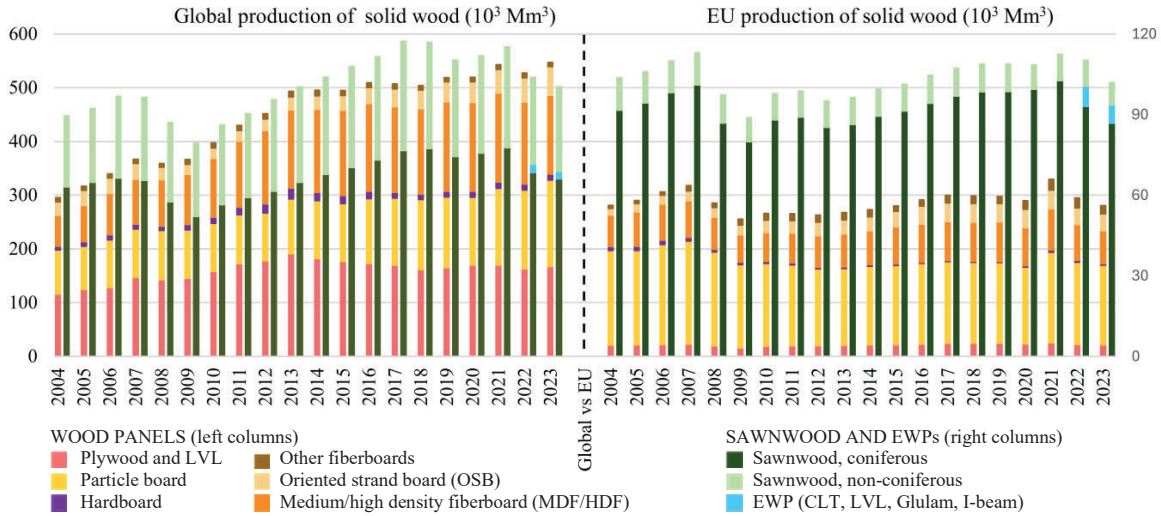

Figure 2. Global (left) and EU-27 (right) production of solid wood (sawnwood and wood-based panels), developed from [21])

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incomplete regarding some countries. For example, CLT volumes in 2020 reached a production volume which varied between 2,5 Mm^3 [25] and 2,8 Mm^3 [26], which are considerably higher than the FAOSTAT figure of 1,2 Mm^3 (2023). However, glulam is the main structural product in Europe in terms of both wood volume and manufacturers. Its production in 2023 amounted 7,1 Mm^3 [21], with the German-speaking countries leading the production [6], [27], [28].

The production of sawnwood and wood-based panels is quite similar globally. In Europe, sawnwood is almost twice as much as panels production. Plywood shows the highest production in volume globally, followed by particleboards. In Europe, particleboards and fibreboards represent the highest shares of production (50% and 30% of the total in 2022). Plywood and OSB are commonly used as walls, floors or roofs in construction, mainly in countries with a strong tradition in building light timber framing dwellings, such as the US [29]. It explains the low production of plywood in Europe, where this constructive system is not so common. OSB and plywood production in Europe represented 12% and 8% of the total in 2022. Particleboards and fibreboards are most commonly used in furniture. In Europe in 2023, the share of particleboards, MDF, plywood and OSB used for construction were 27%, 14%, 38%, and 80% respectively [30].

Table 3. Strength graded wood species in Europe according to EN 1912 [23]

	Wood species	**European Regions[1]**			
		Northern	**Central**	**Southern**	**Eastern**
European softwoods	Fir *(Abies alba)*	✓	✓	FR, IT	✓
	Spruce *(Picea abies)*	✓	✓	FR, IT	✓
	Sitka spruce *(Picea sitchensis)*	✓ (except EE & FI)	DE, LU, NL, PL	FR, IT	✓
	Scots pine *(Pinus sylvestris)*	✓	✓	✓ (except PT)	✓
	European larch *(Larix decidua)*	✓	✓ (except CH)	FR	✓
	Japanese larch *(Larix kaempferi)*	UK			
	Black pine *(Pinus nigra)*	UK		✓ (except PT)	
	Maritime pine *(Pinus pinaster)*			ES, PT	
	Radiata pine *(Pinus radiata)*			ES	
	Douglas fir *(Pseudotsuga menziessii)*	UK	AT, BE, DE	FR, IT	
European hardwoods	Maple *(Acer pseudoplatanus)*		DE		
	Sweet chestnut *(Castanea sativa)*			✓ (except PT)	
	Shinning gum *(Eucalyptus nitens)*			ES	
	Southern blue gum *(Eucalyptus globulus)*			ES	
	Beech *(Fagus sylvatica)*		BE, DE	FR, IT	
	Ash *(Fraxinus excelsior)*		DE		
	Poplar *(Populus ssp).*			FR	
	Oak *(Quercus spp.)*		BE, DE	FR	
Tropical hardwoods	Tropical hardwoods in The Netherlands[2]		NL		
	Tropical hardwoods in France[3]			FR	
	Tropical hardwoods in EU[4]	✓	✓	✓	✓

[1]Countries by regional groupings:
✓ indicates that all countries of the group accounts with visual strength grading for the mentioned wood species. Otherwise only the countries with the strength graded wood species are listed.
Northern (Denmark-DK, Estonia-EE, Finland-FI, Latvia-LV, Lithuania-LT, Norway-NO, Sweden-SE, United Kingdom-UK, Ireland-IE);
Central (Austria-AT, Belgium-BE, Czech Republic-CZ, Germany-DE, Hungary-HU, Luxembourg-LU, The Netherlands-NL, Poland-PL, Slovakia-SK, Slovenia-SI, Switzerland-CH);
Southern (France-FR, Spain-ES, Portugal-PT, Italy-IT);
Eastern (Azerbaijan-AZ, Belarus-BY, Georgia-GA, Moldova-MD, Romania-RO, Russia-European part, Ukraine-UA)

[2] Tropical hardwoods from West and central Africa (Azobé, Bilinga, Lati, Longhi, Osanga, Tali, Okan, Limbali, Kanda), Brazil (Cumaru, Angelim vermelho, Massaranduba, Cupiuba, Guariuba, Tatajuba, a.o.), and from Surinam & Guyana (Basralocus, Demerara greenheart). Species listed in EN 1912. [3] Tropical hardwoods from French Guyana (Massaranduba, Ipe, Amarante, Cupiúba, Mando, Timborana, Jaboty). Species listed in EN 1912. [4] Tropical hardwoods from Cameroon and Congo (Lati, Longhi, Osanga, Tali, Okan, Limbali, Kanda), Guyana (Greenheart), South-East Asia (Kapur, Kempas, Balau, Keruing, Merbau, Teak), tropical Africa (Iroko), West Africa (Azzobé, Bilinga), Central Africa (Sapele), and Western Australia (Karri, Jarrali). Species listed in EN 1912.

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3.2.3. Innovative wood products under EOTA

Innovative products, which are not regulated by CEN, require an alternative route to CE marking: a manufacturer needs to obtain a certification (ETA) for each innovative product before getting the CE marking, which is regulated by EADs of EOTA. The EAD identifies different types of products, while the number of ETA represents the identification number of individual product. In addition, some of the EN standards included in Table 2 are not yet harmonised (e.g. EN 16351 for Cross-Laminated Timber; EN 1316 for Hardwood round timber; EN 1611 for appearance grading of softwoods, etc.). Therefore, the CE marking for these products must necessarily also be obtained via the ETA-EOTA.

In Table 4, a total of 844 innovative products/systems for wood construction with ETA were identified and categorised by product area. In addition, an own categorisation by product type and subtype considering similar EAD, was applied for the purpose of a more practical overview of types regarding their role in construction and to point out their innovation.

Ten identified product areas (PA 4. Thermal insulation products, PA 9. Curtain walling and claddings, PA 12. Road equipment, PA 13. Structural timber products, PA 14. Wood-based panels, PA 19. Floring, PA 21. Wall and ceiling finishes, PA 33. Fixings, PA 34. Building kits, and the European Technical Approval Guidelines (ETAG) for a combination of products which does not account yet with an EAD) contain wood construction products. Products with ETA obtained from ETAG (Table 4) are not yet assigned to any product area. This group is a collection of miscellaneous product types because their categorization by PA is still under way. In total, ETA for wood construction products were obtained from 58 different EAD and from 9 ETAG.

In the analysis per product area, innovative products occur most frequently in PA 13 'Structural timber products, elements and ancillaries': 468 or 55% of 844 total products (Fig. 4). The second most frequent class are miscellaneous wood products and systems that are not yet defined by product area (ETAG used as EAD). The analysis per product type shows that connectors represent the largest number of ETA (333 or 39% of total), followed by timber building kits (177 or 21% of total), structural wood products as the sum of slabs and other structural products (127 or 15%), and thermal insulation materials (93 or 11%). ETA certification showed an increasing trend since 2015 (Fig. 5). The initial version of an ETA represents the first assessment of a new product, whereas the following versions represent an updated assessment of products already registered with an ETA. A drop in the number of new assessments is visible during the COVID period, which however recovered quickly after 2023. Fig. 6 displays the number of issued ETA per country. The countries leading certified innovations are Germany (>200), Austria (>90), Italy (>50), Finland and Poland (>40). An increasing of ETA certifications can be observed also in countries outside Europe (bars with yellow colour in Fig. 6).

To illustrate the variety, a few pictures of innovative products per category are included in Fig. 7, even though you find a substantial variation in design and function even within the same category.

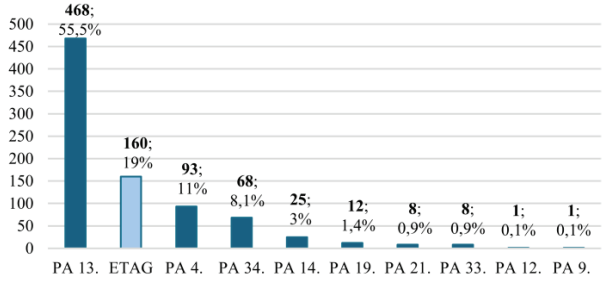

Figure 4. Classification of innovative products in wood construction

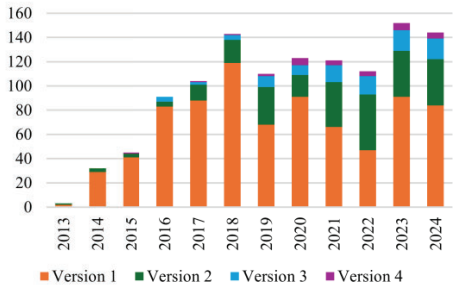

Figure 5: Number of issued ETA versions

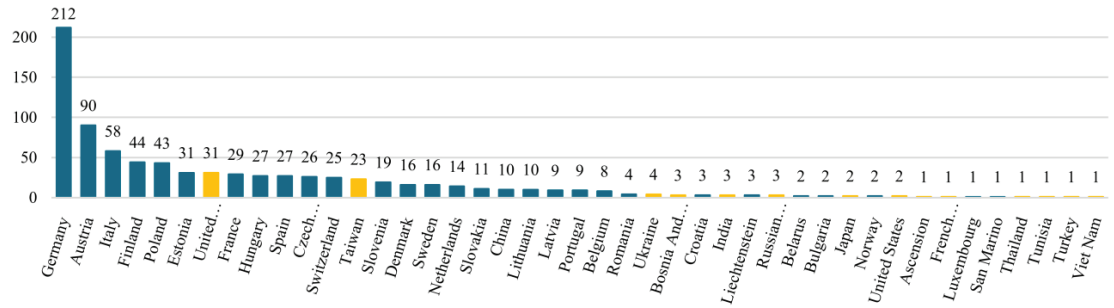

Figure 6: Number of issued ETAs per country.

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Table 4. Quantification of innovative products (by number of ETA) and by product type

Innovative products			EAD		ETA		
PA[1]	Product type	Product subtype	#	by PA	#	by type	by PA
PA 13	Connectors	Three-dimensional nailing plates	1	38	158	333	468
		Screws and threaded rods	2		142		
		Metal dowel type fasteners	1		14		
		Nails and screws for use in nailing plates in timber structures	1		9		
		Glued in rods	1		4		
		Wood dowel type fasteners	2		3		
		Other	3		3		
	Structural products for slabs	CLT- Solid wood slab elements	1		55	66	
		Mechanically jointed or dowel jointed solid wood slab elements	1		10		
		Prefabricated wood slab element made of jointed cross laminated log elements	1		1		
	Other structural products	Composite wood-based beams, columns and slabs with concrete, steel or other materials	2		27	61	
		Glued laminated timber made of softwoods which may be finger jointed or not	13		19		
		Laminated beam or wall made of timber logs	3		9		
		Glued laminated timber made of hardwood	3		6		
	Systems	Modular construction system	3		8	8	
PA 4	Thermal insulation products	In-situ formed loose fill thermal and/or acoustic insulation products made of vegetable fibres	1	5	33	93	93
		External thermal insulation composite systems (ETICS) with renderings for the use of timber frame buildings	1		30		
		Factory-made thermal and/or acoustic insulation products made of vegetable or animal fibres	1		27		
		ETICS with renderings or monolayer or multi-layer wall made of timber	1		2		
		Minerally-bonded boards made of wood chips	1		1		
PA 34	Building kits	Timber building kits	1	3	53	68	68
		Non-load-bearing permanent shuttering kits/systems based on hollow blocks or panels of insulating materials and sometimes concrete	1		14		
		Light weight steel/wood load bearing roof elements	1		1		
PA 14	Wood-based panels	Prefabricated wood-based load-bearing stressed skin panels	1	1	25	25	25
PA 19	Flooring	Underlay made of granulated polyurethane (PU) foam with or without granulated cork	1	2	7	12	12
		Terrace decking kit	1		5		
PA 33	Fixings	Anchor devices for fastening personal fall protection systems to timber structures	2	3	7	8	8
		Fasteners for fixing of external thermal insulation composite systems on timber constructions	1		1		
PA 21	Wall/ceiling finishings and partitions	Soundproofing boards/dry screed and load bearing strips made of corrugated cardboard filled with quartz sand	1	4	3	8	8
		Fibreboards and other composite-based panels for indoor wall design and/or ceiling design	2		3		
		Boards made from recycled beverage cartons, for use in construction	1		2		
PA 9	Curtain walls	Wood based composite panel for façades	1	1	1	1	1
PA 12	Road	Wood and metal composite lighting columns	1	1	1	1	1
ETAG	Several types, not yet categorised (ETAG used as EAD)	Timber building kits	1	9	109	160	160
		Prefabricated wood-based load bearing stressed skin panels	1		21		
		Composite light weight panels	2		15		
		Light composite wood-based beams and columns used as an EAD	1		9		
		Three-dimensional nailing plates	1		3		
		Other	3		3		
TOTAL			67		844		

[1]PA 13: Structural timber products: elements and ancillaries; PA4: Thermal insulation products, composite insulation kits/systems; PA 34: Building kits, units prefabricated elements; PA 19: Flooring; PA14: Fixings; PA 21: Wall and ceiling finished, internal partition kits; PA 9. Curtain walling, structural sealant glazing; PA 12: Road equipment: circulation fixtures. and a combination of different products defined in European Technical Approval Guidelines (ETAG) which do not have yet an EAD and, therefore, they are not yet assigned to any PA.

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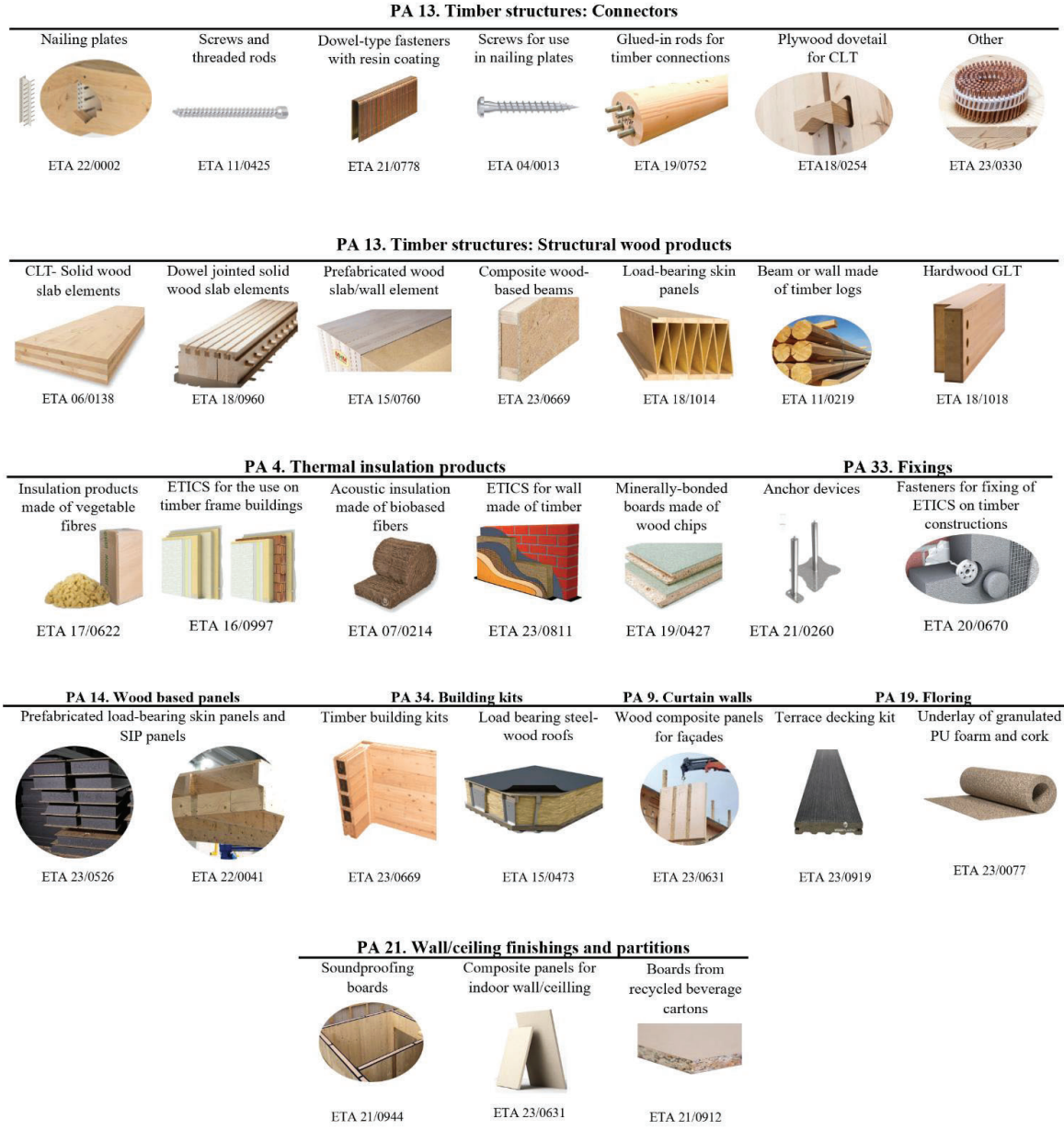

Figure 7: Examples of innovative products in wood construction

4 – CONCLUSIONS

While timber buildings have a long history worldwide, wood has been replaced by other building materials over the last century, led by emerging industrial construction techniques and denser infrastructures with multistorey buildings in cities. In recent decades, growing interest in novel, efficient production systems and products such as prefabrication and in decarbonization benefits of EWP have however led to a new boom in timber construction in European countries. The share of wood (in m^3) in the total consumption of construction materials remains still quite low globally (7%), but Europe is progressing fast to increase this position (13%). A highly productive timber industry is the initial link in the value chain of EWP into buildings.

Timber construction relies primarily on five softwood species, mostly spruce, although the diversity of wood

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species in European forests is much larger. A recent trend towards more diversification of softwood and hardwood species for structural applications can be observed. Also, more wood species from outside of Europe are being graded in accordance with European standards, mainly tropical hardwoods from Africa and Asia.

The CPR requires mandatory CE marking for the commercialisation of any construction product in Europe to ensure that the safety, performance, and sustainability requirements are met by means of harmonised European standards (hEN) regulated by CEN. However, the number of hEN for wood products in construction is still quite limited.

Manufacturers of innovative products not regulated by hEN of CEN can obtain an ETA for each product through the EOTA, which gives access to CE marking. The study identified 844 innovative products for wood construction with a registered ETA. The bulk of 468 innovations are found in the product area of timber structures. Novel connectors for industrial timber construction (mostly steel, but also wooden) are the main group (39%). Many novel EWP and construction systems are also notable, such as timber building kits (21%), structural wood products (15%) and thermal insulation materials (11%). The large numbers of products identified reveal the growing R&D capacity of European wood engineering companies and machine manufacturers, with the top 5 countries Germany, Austria, Finland, Italy and Poland.

The study highlights the important role of innovation as a driver in timber construction, linked to a new tendency towards more standardized, but at the same time complex buildings and supply chains that characterise the construction industry. The innovations address enhanced performance, advanced design, prefabrication systems, and material efficiency, among others. More systematic research on the role of industrial innovation and standards in timber construction is needed, to follow and to guide the upscaling of markets more closely.

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6 – AUTHOR CONTRIBUTIONS

Vanesa Baño: lead researcher, conceptualisation, methodology, analysis, original draft preparation, writing, supervision; Peter Romih: database collection, data analysis, writing; Jan-Willem van de Kuilen: writing, review and editing; Uwe Kies: conceptualisation, analysis, funding acquisition, writing, review and editing supervision. All authors have read and agreed to the published version of the manuscript.

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