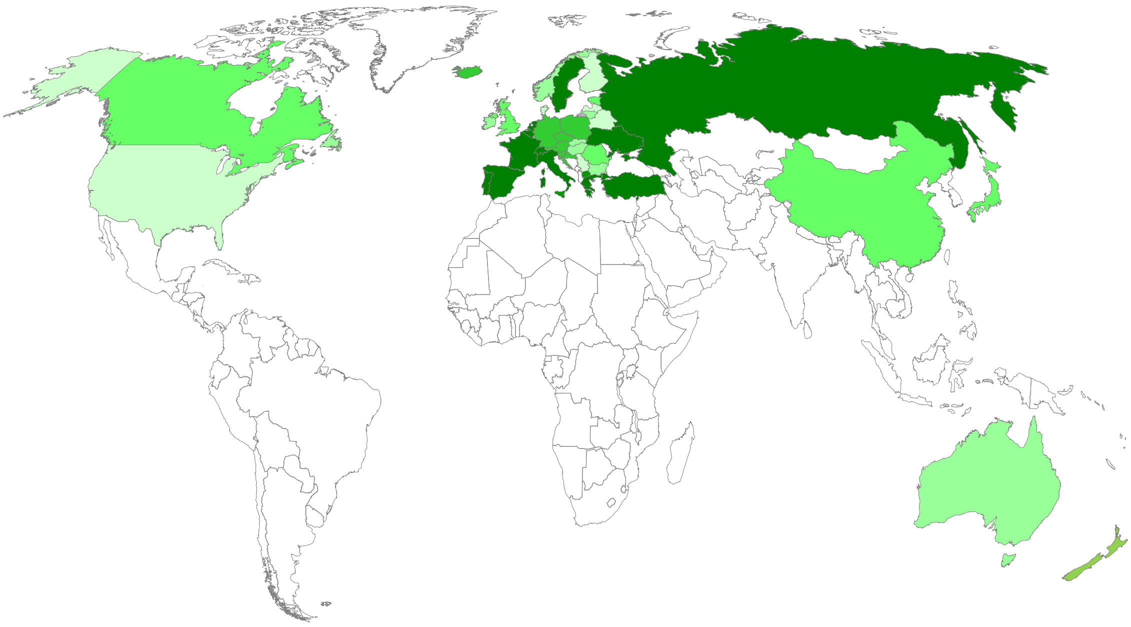
Linnæus University
Sweden

National fire regulations for the use of wood in buildings - Worldwide review 2020

Birgit Östman



Report,rev
ISBN 978-91-89283-39-8
Lnu Linnaeus University
Faculty of Technology

Linnæus University
Sweden

Linnæus University
Sweden

Preface

This study has been performed as a follow up of a similar study in 2002 [1] and in order to provide information to other publications, mainly the *Fire Safe Use of Wood - Global Design Guide,* that has been published in 2022 [4].

A few minor corrections to the first version have been included.

Birgit Östman
Linnaeus University
Växjö, Sweden

Contents

Summary

The possibilities for building in wood have gradually increased in recent decades mainly due to environmental benefits and increased knowledge on wood building techniques. But there are still restrictions in terms of fire regulations in many countries, especially for taller buildings. The situation has therefore been mapped in 40 countries at four continents with regard to how high buildings with load-bearing wooden frames may be built and how much visible wood may be used both inside the building on walls and ceilings in apartments and outside on the facades. In escape routes, the wall and ceiling linings shall be non-combustible in most countries.

The restrictions apply primarily to prescriptive fire design with detailed rules, which are mainly used for residential buildings and offices. For more complicated constructions e.g. public buildings, shopping centers, arenas and assembly halls, performance based design can be used by fire safety engineering using e.g. evacuation and smoke filling, which increases the possibilities of using wood in buildings.

The possibilities to use wood in buildings increase in several countries if sprinklers are installed, which is highlighted.

The conclusion is that the differences are still large and that many countries have not yet started to use wood in larger buildings despite supplies of forest resources and environmental benefits.

Swedish summary – Svensk sammanfattning

Möjligheterna att bygga i trä har succesivt ökat under de senaste decennierna, främst beroende på miljöfördelar och ökad kunskap om träbyggnadsteknik. Men fortfarande finns begränsningar i form av brandbestämmelser i många länder, särskilt när det gäller högre hus. Situationen har därför kartlagts i ett 40-tal länder i fyra världsdelar med avseende på hur höga hus med bärande trästomme som får byggas och hur mycket synligt trä som får användas både invändigt på väggar och i innertak i lägenheter och utvändigt på fasader. I utrymningsvägar ska beklädnader på väggar och i tak vara obrännbara i flertalet länder.

Begränsningarna gäller framförallt vid brandteknisk dimensionering enligt så kallad förenklad dimensionering med detaljregler, som används främst för bostäder och kontor. För mer komplexa byggnader t.ex. offentliga lokaler, köpcentra, arenor och samlingslokaler kan brandteknisk ingenjörsvetenskap användas med hjälp av modeller för bl.a. utrymning och rökfyllnad, vilket ökar möjligheterna att använda trä i byggnader.

Möjligheterna att använda trä i byggnader ökar om sprinkler installeras, vilket också belyses.

Slutsatsen är att skillnaderna fortfarande är stora och att många länder ännu inte börjat använda trä i större byggnader trots stora tillgångar på träråvaror och miljöfördelar.

Background

The combustibility of wood is one of the main reasons why many building regulations strongly restrict the use of wood as a building material. Fire safety is an important contribution to feeling safe, and an important criterion for the choice of materials for buildings. The main precondition for increased use of wood products and structures in buildings is adequate fire safety.

World-wide, several research projects on the fire behavior of wood structures have been conducted in recent decades, aimed at providing basic data and information on the fire safe use of wood in buildings. Novel fire design concepts and models have been developed, based on extensive testing and calculations. The current improved knowledge in fire design of wood structures, combined with technical measures, particularly sprinkler and smoke detection systems, and well-equipped fire services, allow the safe use of wood in a wide field of application. As a result, many countries are revising their fire regulations, thus permitting greater use of wood. Overviews are available [1-3].

Fire test and classification methods have been harmonized internationally, but regulatory requirements applicable to building types and end uses remain on national bases. Although these standards exist on the *technical level*, fire safety is governed by national legislation, and is thus on the *political level*, but further harmonization will hopefully provide means of achieving common national regulations.

Fire safety in buildings

There are two different stages of a fire scenario to be considered in the fire safety design of buildings in relation to building materials and structures. These are the initial and the fully developed fire, see Figure 1. In the initial fire, the building content e.g. furniture is of major importance both for the initiation of the fire and its development, but the building content is not regulated in the national building codes. Surface linings may contribute in the initial fire, especially in escape routes, since those are required to be without any furniture and furnishing. Limitations of the reaction to fire of surface linings are required in most national building codes. In the fully developed fire, i.e. after flashover in a room, the performance of load bearing and separating structures is important in order to limit the fire to the room or compartment of fire origin. This is called the fire resistance of the building structure.

Generally speaking, wood structures can obtain high performance for fire resistance and high levels for the separating and load-bearing capacity of wall and floor structures can be achieved, while the surface properties of wooden linings in the initial fire may be less favorable and also more difficult to quantify. The highest levels of the reaction to fire properties cannot be obtained by ordinary wood-based products.

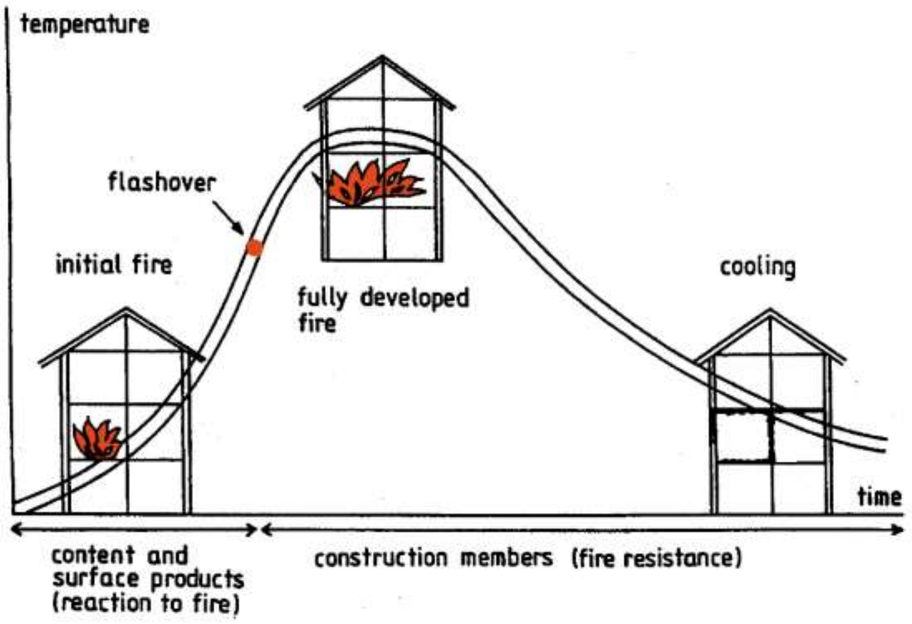


Figure 1. Two main stages are relevant for the fire safety in buildings:

- *the initial fire (reaction to fire performance of surfaces)*
- *the fully developed fire (fire resistance of structural elements).*

Both stages have requirement levels in most national fire regulations.

National regulations - Questionnaire

In order to review the present situation, a questionnaire was sent out to colleagues and contacts from international networks, e.g. FSUW Fire Safe Use of Wood. The response was very good and national information from 40 countries at four continents was received, see Acknowledgements.

The questionnaire was called
National requirements on Fire resistance and Reaction to fire performance in timber buildings according to prescriptive design (detailed requirements).

It contained questions on requirements for residential and office buildings, some questions on possibilities for using performance-based design and space for commenting on specific items. The questions were given for design with and without sprinkler installations, which makes differences in some countries.

A main parameter was height of the building. It could be expressed in maximum number of storeys or in maximum height of the building in meters. These parameters are defined partly different in different countries and in some countries only one of the measures is used. The conversion between the two may also be different, so some simplifications have been used to present comparable data.

The building height has been grouped in 4 categories:

- 0-2 storeys
- 3-4 storeys
- 5-8 storeys
- > 8 storeys incl. No Limits in some countries

The national information has been compiled in tables and maps in the next chapters.

Structural use of wood - Tables

Table 1a. *Maximum number of storeys/maximum height and fire resistance requirements on load-bearing elements in* ***residential*** *timber buildings – Prescriptive / Pre-accepted requirements*

Country	**Max number of storeys ***		**Max height, m**		**Same for all materials**	**Addi-tional req. for wood**	**PFB design allowed**	**Valid since**	**Fire resistance requirements, minutes Residential buildings**			
									Max number of storeys			
	Unspr.	Spr.	Unspr.	Spr.					1-2	3-4	5-8	> 8
Australia	2-3	(8)	-	25	Yes	Yes	Yes	2019	30-60	60-90	90	-
Austria	(7)[2]	(7)	22	-	Yes	Yes	Yes	2019	30-60	30-90	60-90	-
Belarus	2	2	-	-	No	No	No	2018	-	-	-	-
Belgium	NL[2]	NL	NL	NL	Yes	No	Yes	2020	30	30-60	60-120	120
Bulgaria	1-2	(4)	-	12	-	No	No	2010	-	30	60	120
Canada	3	12	-	42	No	Yes	Yes	2020	45	45-60	60[1]/120	120
China	3	5	10	-	Yes/No	Yes	Yes	2017	30	60	120	-
Croatia	(7)	(7)	22	22	Yes	Yes	Yes	2015	30	60	90	-
Czech Rep.	(3-4)	(3-4)	9-12	9-12	No	Yes	Yes	1980+	15[2]/30	30[2]/60	45[2]/60	-
Denmark	(3-4)[2]	(3-4)	12[2]	12	No	Yes	Yes	2020	60	60	-	-
Estonia	4	8	-	-	No	Yes	Yes	2017	30	60-180	60[2]/120	-
Finland	2	8	9	28	No	Yes	Yes	2011	30	60[2]	60[2]	-
France	(16)	(16)	50	50	No	No	Yes	1986	15-30	30-60	60	90-120
Germany	(7-8)	(7-8)	22	22	Yes	Yes	Yes	2021	30	60	90	-
Greece	NL	NL	NL	NL	Yes	No	No	2018	30	60	60-90	90-120
Hungary	3	3	14	14	Yes	Yes	Yes	2020	15	30		
Iceland	8	NL	23	NL	Yes	No	Yes	2012	30/90[3]	60[4]/90	60[4]/90	90[4]/120
Ireland	3	4	10	10	No	Yes	Yes/No	2006	30	30-60	-	-
Italy	NL	NL	NL	NL	Yes	No	Yes	2006			60	90-120
Japan	3	3	16	16	Yes	Yes	Yes	2019	45/60	60	-	-
Latvia	(7)[2]	(7)[2]	21[2]	21[2]	Yes	Yes	(Yes)	2018	30	30[2]-60	60[2]	60[2]-180
Lithuania	(3)	(3)	10	10	Yes	No	No	2010	NL	45	60-120	60-120
Netherlands	NL	NL	NL	NL	Yes/No	No	Yes/no	2012		60	90	120
New Zealand	20	20	25	-	Yes	No	Yes	2020	60/30[4]	60/30[4]	60/30[4]	60/30[4]
Norway	4	4	-	-	Yes	No	Yes	2007	30	60	-	-
N Macedonia	1-2	1-2	6-9	6-9	Yes	No	No	1984	120	120	120	120
Poland	8	> 8	25	> 25	Yes	No	No	2017	30	30	30	120
Portugal	NL	NL	NL	NL	Yes/No	No	No	2009	30	30	60	90
Romania	3	4	-	-	No	Yes	Yes	1999	-	-	-	-
Russia	NL	NL	75	75	Yes	Yes	Yes	2012	0-30[2]	45	45	90[4]-120
Serbia	1-2	1-2	6-9	6-9	Yes/No	Yes	Yes	2019	15-30	30-60	-	-
Slovakia	3	3	-	-	No	Yes	No	2019	15-30	30-60	-	-
Slovenia	6	(7)	-	22	No	Yes	Yes	2019	-	-	-	-
Spain	NL	NL	NL	-	Yes	No	Yes	2019	30	60	90	120
Sweden	NL	NL	NL	NL	Yes	No	Yes	2012	60	60	60-90[2]	90
Switzerland	(33)	(33)	100	100	Yes	No	Yes	2015	0[4]/30	0[4]/30	30[4]/60	60[4]/90
Turkey	10	NL	30,5	NL	No	No	No	2007	30[2]/60	60[2]	60[2]	90/120[2]
Ukraine	NL	NL	NL	NL	Yes	Yes	Yes	2016	30	30	60	120-180
UK	3-4	NL	11	NL	Yes	No	Yes	2020	30	60	60[4]/90	90[4]/120
US	0	(18)	0	83	No	Yes	Yes	2021	0	0[4]/30	60[4]/120	120[4]/180

* storey height estimated to 3 m, if only building height specified in national answers (estimated number of storeys in brackets)
NL = No Limit for wood
PBD = Performance Based Design
[1] for 5-6 storeys
[2] additional details apply
[3] if different storeys and, in some countries, different fire compartments; [4] with sprinklers

Table 1b *Maximum number of storeys/maximum height and **fire resistance** requirements on **load-bearing** elements in **office** timber buildings – Prescriptive / Pre-accepted requirements*

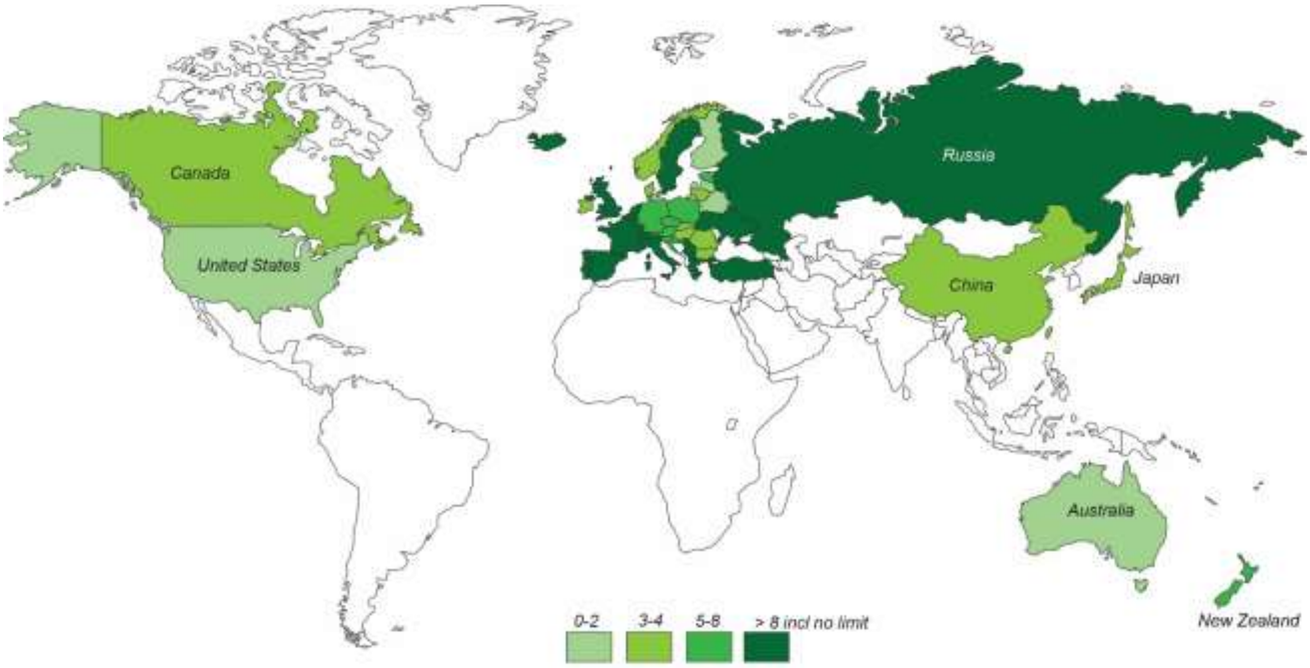
Country	Max number of storeys *		Max height, m		Same for all materials	Addi-tional req. for wood	PFB design allowed	Valid since	Fire resistance requirements, minutes Office buildings			
									Max number of storeys			
	Unspr.	Spr.	Unspr.	Spr.					1-2	3-4	5-8	> 8
Australia	2	(8)		25	Yes	Yes	Yes	2019	60-90	90-120	90-120	90-120
Austria	(7)[2)]	(7)	22	-	Yes	Yes	Yes	2019	30-60	30-90	60-90	-
Belarus	2	2	-	-	-	-	-	2018	-	-	-	-
Belgium	NL[2)]	NL	-	-	Yes	No	Yes	2020	30	30-60	60-120	120
Bulgaria	1-2	(4)	-	12	-	No	No	2010	-	30	60	120
Canada	3	12	-	42	No	Yes	Yes	2020	45	45-60	60[1)]/120	120
China	3	5	10	-	Yes/No	Yes	Yes	2017	30	90	120	
Croatia	(7)	(7)	22	22	Yes	Yes	Yes	2015	30	60	90	-
Czech Rep.	(3-4)	(3-4)	9-12	9-12	No	Yes	Yes	1980+	15[2)]/30	30[2)]/60	45[2)]/60	-
Denmark	(3-4)[2)]	(3-4)	12[2)]	12	No	Yes	Yes	2020	60	60	-	-
Estonia	4	8	-	-	No	Yes	Yes	2017	30	60-180	120-240	-
Finland	2	8	9	28	No	Yes	Yes	2011	30	60 [2)]	60 [2)]	-
France	(9)	(9)	28	28	No	Yes	Yes	1992	0	60	60	90
Germany	(7-8)	(7-8)	22	22	Yes	Yes	Yes	2021	30[2)]	60[2)]	90	-
Greece	NL	NL	NL	NL	Yes	No	No	2018	30	60	60-90	90-120
Hungary	3	3	14	14	Yes	Yes	Yes	2020	15	30	-	-
Iceland	8	NL	23	NL	Yes	No	Yes	2012	30/90[3)]	60[2)]/90	60[2)]/90	90[2)]/120
Ireland	3	4	10	10	No	Yes	Yes/No	2006	30	30/60	-	-
Italy	NL	NL	NL	NL	Yes	No	Yes	2006	30	30/60	60	90/120
Japan	3	3	16	16	Yes	Yes	Yes	2019	60/45	60	-	-
Latvia	(7)[2)]	(7)[2)]	21[2)]	21[2)]	Yes	Yes	(Yes)	2018	30	30[2)]-60	60[2)]	60[2)]-180
Lithuania	(3)	(3)	10	10	Yes	No	No[4)]	2010	NL	45	60-120	60-120
Netherlands	NL	NL	NL	NL	Yes/No	No	Yes/No	2012	-	60	90	-
New Zealand	8	20	25	60	Yes	No	Yes	2020	60/30[4)]	60/30[4)]	60/30[4)]	60/30[4)]
Norway	4	4	-	-	Yes	No	Yes	2007	30	60	-	-
N Macedonia	1-2	1-2	6-9	6-9	Yes	No	No	1984	120	120	120	120
Poland	8	> 8	25	> 25	Yes	No	No	2017	30	30	30	120
Portugal	NL	NL	NL	NL	Yes/No	No	No	2009	30	30	60	90
Romania	3	4	-	-	No	Yes	Yes	1999	-	-	-	-
Russia	16	NL	50	NL	Yes	No	Yes	2014	-	45	90	120
Serbia	1-2	3	10	10	No	Yes	Yes	2019	30-60	60-90	-	-
Slovakia	4	4	12	12	No	Yes	No	2019	15-30	30-60	-	-
Slovenia	6	7	-	-	No	Yes	Yes	2019	-	-	-	-
Spain	NL	NL	NL	-	Yes	No	Yes	2019	30	60	90	120
Sweden	NL	NL	NL	NL	Yes	No	Yes	2012	60	60	60-90[2)]	90
Switzerland	(33)	(33)	100	100	Yes	No	Yes	2015	0[4)]/30	0[4)]/30	30[4)]/60	60[4)]/90
Turkey	10	NL	30,5	NL	No	No	No	2007	30/30[2)]	60/30[2)]	60/30/90[2]	90/120[2)]
Ukraine	NL	NL	NL	NL	-	Yes	Yes	2016	30	30	60	120-180
UK	10	NL	30	NL	Yes	No	Yes	2020	30	30[4)]/60	60[4)]/90	90[4)]/120
US	5	18	19,8	83	No	Yes	Yes	2021	0	0[4]/60	60-120	120-180

* storey height estimated to 3 m, if only building height specified in national answers (estimated number of storeys in brackets)
NL = No Limit for wood
PBD = Performance Based Design
1) for 5-6 storeys
2) additional details apply
3) if different storeys and, in some countries, different fire compartments
4) with sprinklers

Structural use of wood - Maps

Maximum number of storeys with <u>load-bearing</u> timber structure in <u>residential</u> buildings

<u>Without</u> sprinklers



<u>With</u> sprinklers

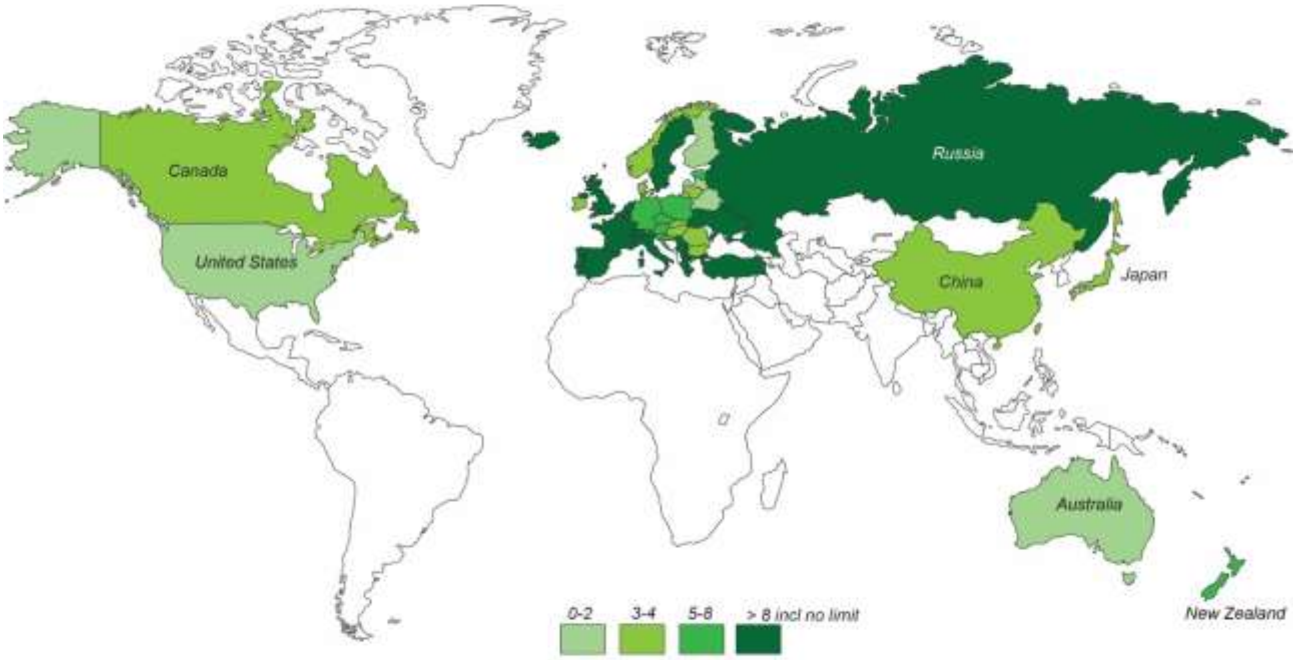
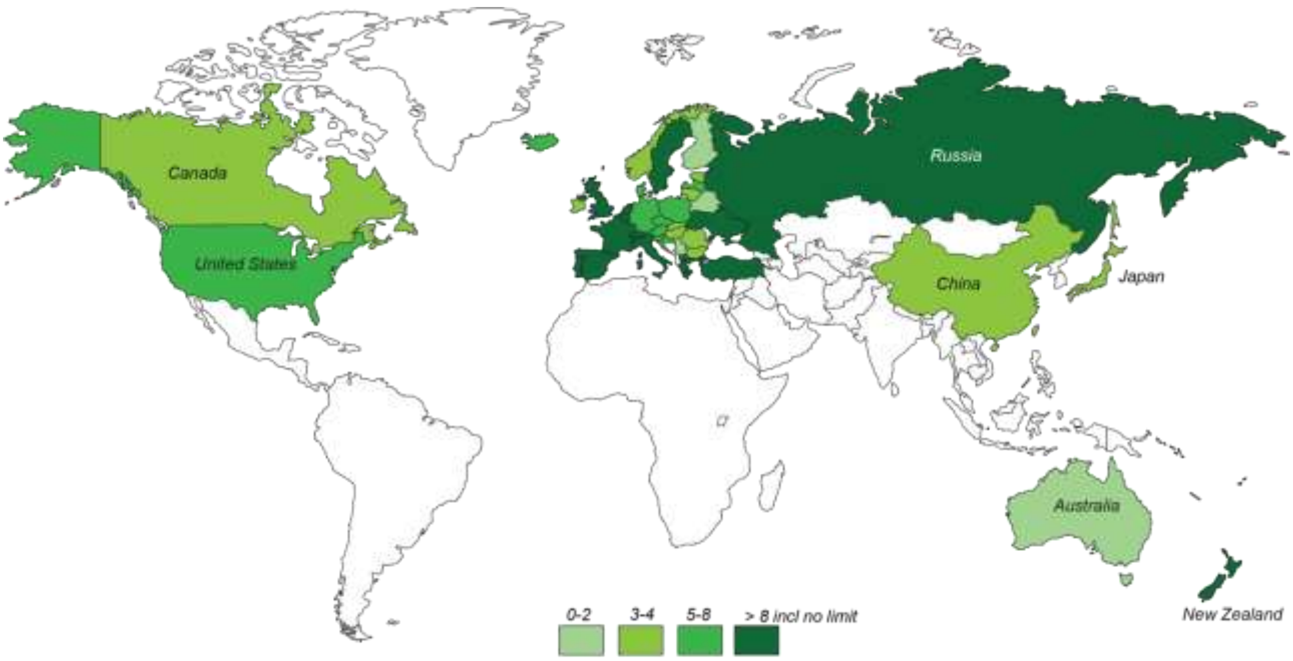


*Figure 2. Maximum number of storeys with **load-bearing elements** in wood in **<u>residential</u>** buildings acc. to prescriptive requirements; **<u>above without</u>** sprinklers and **<u>below with</u>** sprinklers installed.*

Maximum number of storeys with load-bearing timber structure in office buildings

Without sprinklers



With sprinklers

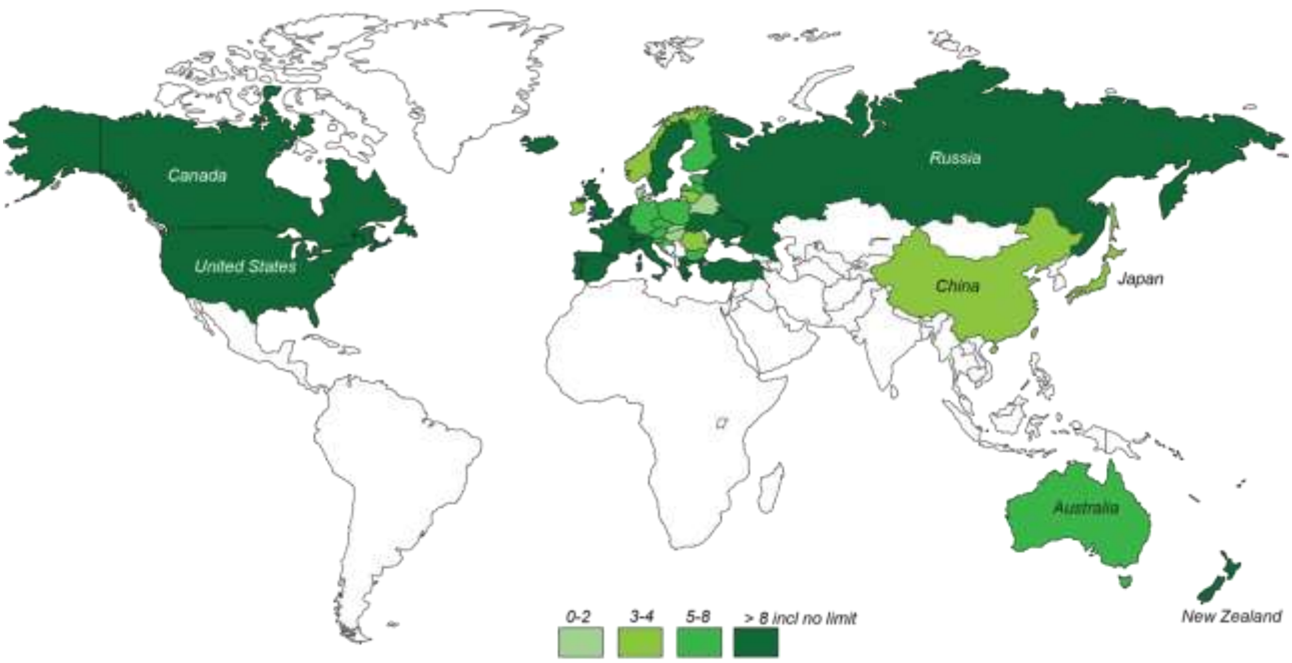


*Figure 3. Maximum number of storeys with **load-bearing elements** in wood in **office** buildings acc. to prescriptive requirements; **above without** sprinklers and **below with** sprinklers installed.*

Visible wood, facades and interior applications - Tables

Table 2a. Maximum number of storeys for ***visible wood surfaces****, exterior and interior – Reaction to fire requirements in* ***residential buildings*** *– Prescriptive / Pre-accepted requirements*

Country	Maximum number of storeys generally										
	Facades - exterior			Wall and ceiling linings - interior						Floorings	
				Flats			Escape routes			Flats	Escape routes
	Wood, untr. °		FRT wood °	Wood, untr.		FRT wood °	Wood, untr.		FRT wood °	Wood, untr.	
	Unspr.	Spr.		Unspr.	Spr.		Unspr.	Spr.		Unspr.	Unspr.
Australia	2	2	2	NL	NL	NL	0	0	0	NL[1]	NL[1]
Austria	6[2]	6	6	NL	NL	NL	3-4	3-4	4	NL	3-4°
Belarus	-	-	-	-	-	-	-	-	-	-	-
Belgium	2-3	2-3	8	NL	NL	NL	0	0	-	NL	0
Bulgaria	2-3	2-3	7-8	2-3	-	2-3	0	0	0	NL	-
Canada	3	6	6	3	6	NL	0	0	NL	3	3
China	-	-	-	0	0	-	-	-	-	0	-
Croatia	2-3	2-3	≤ 7	≤ 22	NL	≤ 22	2-3	2-3	2-3	-	2-3
Czech Rep.	5[2]	5[2]	5[2]	NL	NL	NL	4[2]	4[2]	4[2]	NL	4[2]
Denmark	1	2	1	1-7[2]	1-7[2]	-	0	0	-	NL	NL°
Estonia	8	8	NL	NL	NL	NL	0	0	8	NL	NL
Finland	2	8	8	NL	NL	NL	0	0	-	NL	NL
France	9	9	9	50	50	50	0	0	3	NL	0
Germany	7-8	7-8	7-8	7-8[2]	7-8[2]	7-8[2]	0	0	0	NL	7-8
Greece	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL
Hungary	NL	NL	-	NL	NL	-	NL	NL	-	NL	NL
Iceland	-	NL	NL	1-2	NL	NL	0	0	NL	NL	≤ 23 m
Ireland	4	-	-	0	0	-	0	0	-	NL	NL
Italy	5-8°	5-8°	5-8°	NL	NL	NL	0	0	NL	NL	0
Japan	0	0	0	NL	NL	NL	0	0	NL	0	0
Latvia	3	3	9	NL	NL	NL	3	3	-	NL	NL°
Lithuania [2]	2	2	4	4	4	NL	2	2	4	4	2
Netherlands	4	4	NL	NL	NL	NL	0	0	-	NL	0
New Zealand	3-4	3-4	3-4 [5]	20	20	20	0	0	20	8	8
Norway	1-2	1-2	-	3-4	3-4	-	0	0	NL	NL	NL
N Macedonia	-	-	-	-	-	-	-	-	-	-	-
Poland	8	8	8	NL	NL	NL	0	0	NL	NL	0
Portugal	10	10	-	NL	NL	NL	0	0	0	NL	0
Romania	3	4	-	3	4	-	3	4	-	3	4
Russia	2	2	-	NL	NL	NL	2	2	2	NL	2
Serbia	-	-	-	-	-	-	-	-	-	-	-
Slovakia	5	5	5	NL	NL	NL	3	3	3	NL	NL
Slovenia	3-4	3-4	-	NL	NL		0	0	-	NL	0
Spain	3	3	-	NL	NL	NL	0	-	NL	NL	0
Sweden	2	2	8	2	8	NL	0	0	NL	NL	NL°
Switzerland	10	10	10	10	30	30[2]	10[2]	10[2]	30[2]	30	30[2]
Turkey	-	-	-	-	-	-	-	-	-	-	-
Ukraine	2	2	2	NL	NL	NL	0	0	0	NL	0
UK	3-4	6	6	0	0	NL	0	0	NL	-	-
US	0	4	6°	NL[°,2]	NL[°,2]	NL	0	NL°	NL	NL	NL

NL = No Limit for wood
° Only if meeting required class
[1] Minimum Critical Radiant Flux apply, not all timber species can comply
[2] additional details apply; [3] if > 10 m to other buildings; [4] with sprinklers; [5] up to 20 if passes full scale façade test

*Table 2b. Maximum number of storeys for **visible wood surfaces**, exterior and interior – Reaction to fire requirements in **office buildings** – Prescriptive / Pre-accepted requirements*

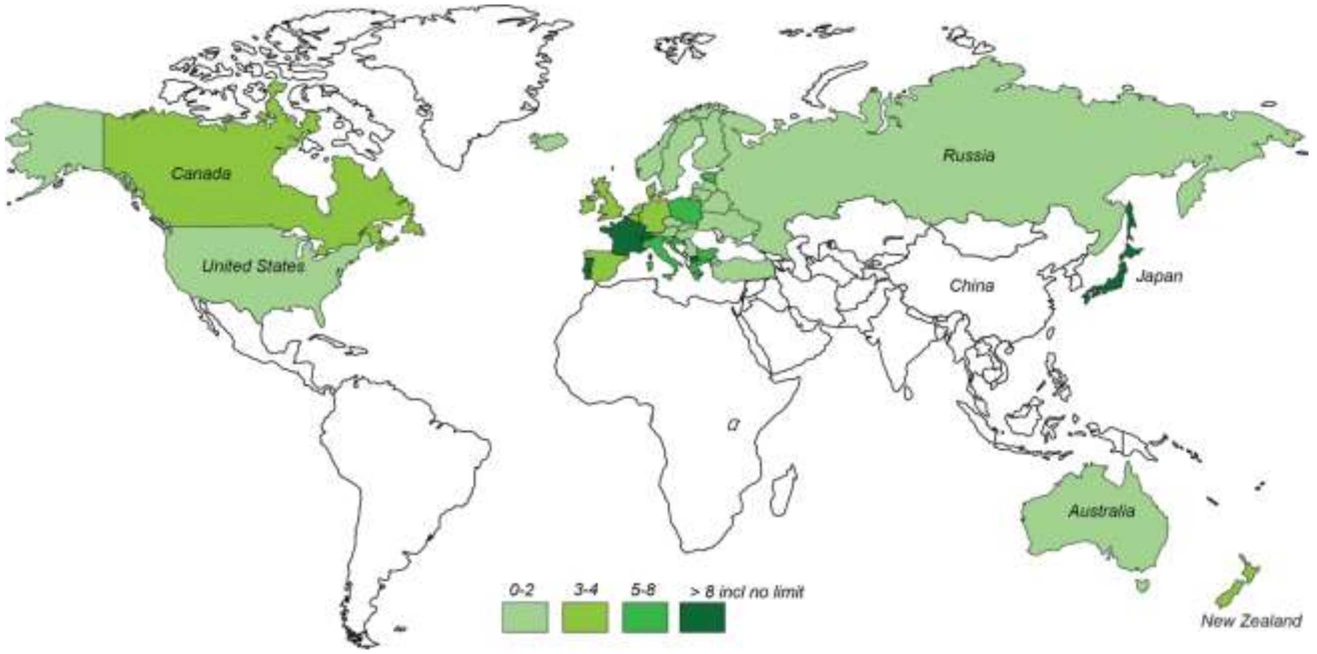
Country	Maximum number of storeys generally										
	Facades - exterior			Wall and ceiling linings - interior						Floorings	
				Office space			Escape routes			Office space	Escape routes
	Wood, untr.		FRT wood °	Wood, untr.		FRT wood °	Wood, untr.		FRT wood °	Wood, untr.	
	Unspr.	Spr.		Unspr.	Spr.		Unspr.	Spr.		Unspr.	Unspr.
Australia	2	2	2	NL	NL	NL	0	0	0	NL[1)]	NL[1)]
Austria	6[2)]	6	6	NL	NL	NL	3-4	3-4	4	NL	3-4°
Belarus	-	-	-	-	-	-	-	-	-	-	-
Belgium	2-3	2-3	8	NL	NL	NL	0	0	-	NL	0
Bulgaria	2-3	2-3	7-8	2-3	2-3	2-3	0	0	0	NL	-
Canada	3	6	6	3	6	NL	0	0	NL	3	3
China	-	-	-	0	0	-	-	-	-	0	-
Croatia	2-3	2-3	≤ 7	≤ 22	NL	≤ 22	2-3	2-3	2-3	-	2-3
Czech Rep.	5[2)]	5[2)]	5[2)]	NL	NL	NL	4[2)]	4[2)]	4[2)]	NL[2)]	4[2)]
Denmark	1	2	1	1-7[2)]	1-7[2)]	-	0	0	-	NL	NL°
Estonia	8	8	NL	NL	NL	NL	0	0	8	NL	NL
Finland	2	8	8	NL	NL	NL	0	0	-	NL	NL
France	9	9	9	2	-	9	0	-	9	9	9
Germany	7-8	7-8	7-8	7-8[2)]	7-8[2)]	7-8[2)]	0	0	0	NL	7-8
Greece	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL
Hungary	NL	NL	-	NL	NL	-	NL	NL		NL	NL
Iceland	-	NL	NL	1-2	NL	NL	0	0	NL	NL	≤ 23 m
Ireland	6	-	-	0	0	-	0	0	-	NL	NL
Italy	5-8°	5-8°	5-8°	NL	NL	NL	0	0	NL	NL	0
Japan	0	0	0	10	10	NL	0	0	NL	0	0
Latvia	3	3	9	NL	NL	NL	3	3	-	NL	NL°
Lithuania [2)]	2	2	4	4	4	NL	2	2	4	4	2
Netherlands	4	4	NL	NL	NL	NL	0	0	-	NL	0
New Zealand	3-4	3-4	3-4 [5]	20	20	20	0	0	20	8	8
Norway	1-2	1-2	-	3-4	3-4	-	0	0	NL	NL	NL
N Macedonia	-	-	-	-	-	-	-	-	-	-	-
Poland	8	8	8	NL	NL	NL	0	0	NL	NL	0
Portugal	10	10	-	0	0	NL	0	0	0	0	0
Romania	2	3	-	2	3	-	2	3	-	2	3
Russia	2	2	-	NL	NL	NL	-	-	-	NL	-
Serbia	-	-	-	-	-	-	-	-	-	-	-
Slovakia	5	5	5	NL	NL	NL	3	3	3	NL	NL
Slovenia	3	5	-	NL[3)]	NL[3)]	-	0	0	-	0	0
Spain	3	3	-	0	0	NL	0	-	NL	NL	0
Sweden	2	2	8	2	8	NL	0	0	NL	NL	NL°
Switzerland	10	10	10	10	30	30[2)]	10[2)]	10[2)]	30[2)]	30	30[2)]
Turkey	-	-	-	-	-	-	-	-	-	-	-
Ukraine	2	2	2	NL	NL	NL	0	0	0	NL	0
UK	6/NL°	6/NL°	NL	0	0	NL	0	0	NL	-	-
US	4	4	6	NL[°,2)]	NL[°,2)]	NL°	0	NL°	NL°	NL°	NL

NL = No Limit for wood
° Only if meeting required class
[1)] Minimum Critical Radiant Flux apply, not all timber species can comply
[2)] additional details apply
[3)] if > 10 m to other buildings
[4)] with sprinklers; 5) if passes full scale façade test

Wooden facades – Maps

Maximum number of storeys with <u>wooden facades</u> in <u>residential</u> buildings

<u>Without</u> sprinklers



<u>With</u> sprinklers

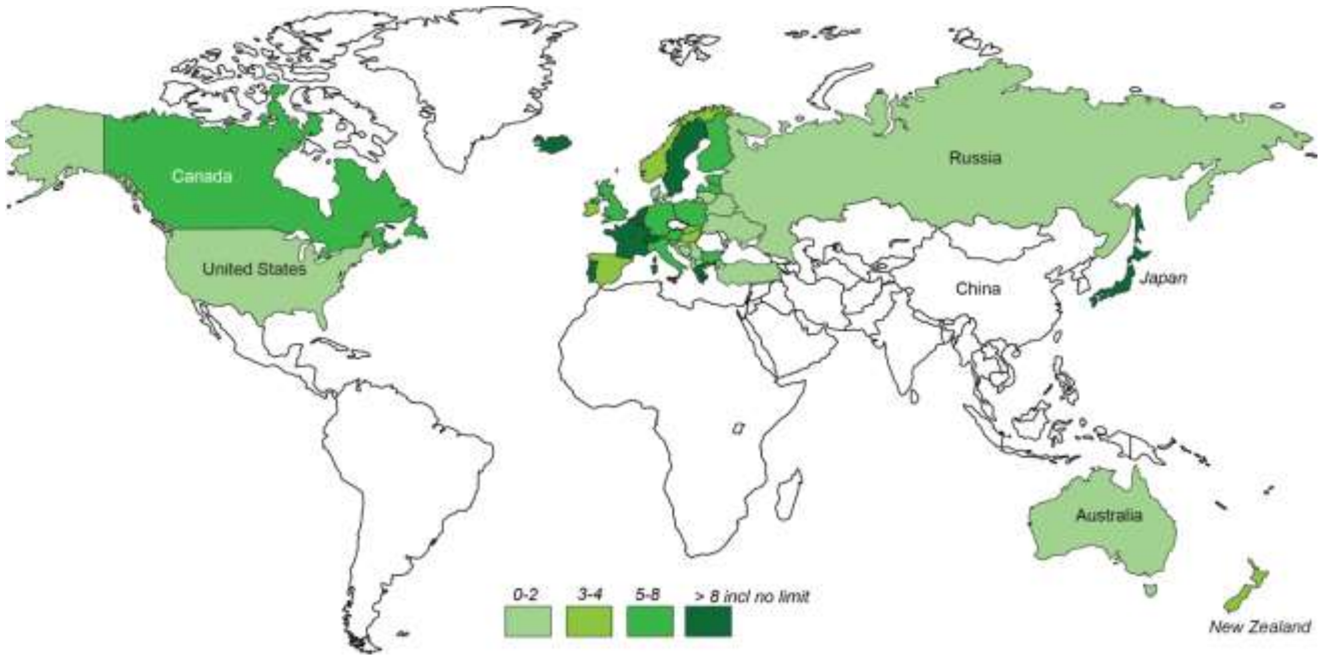
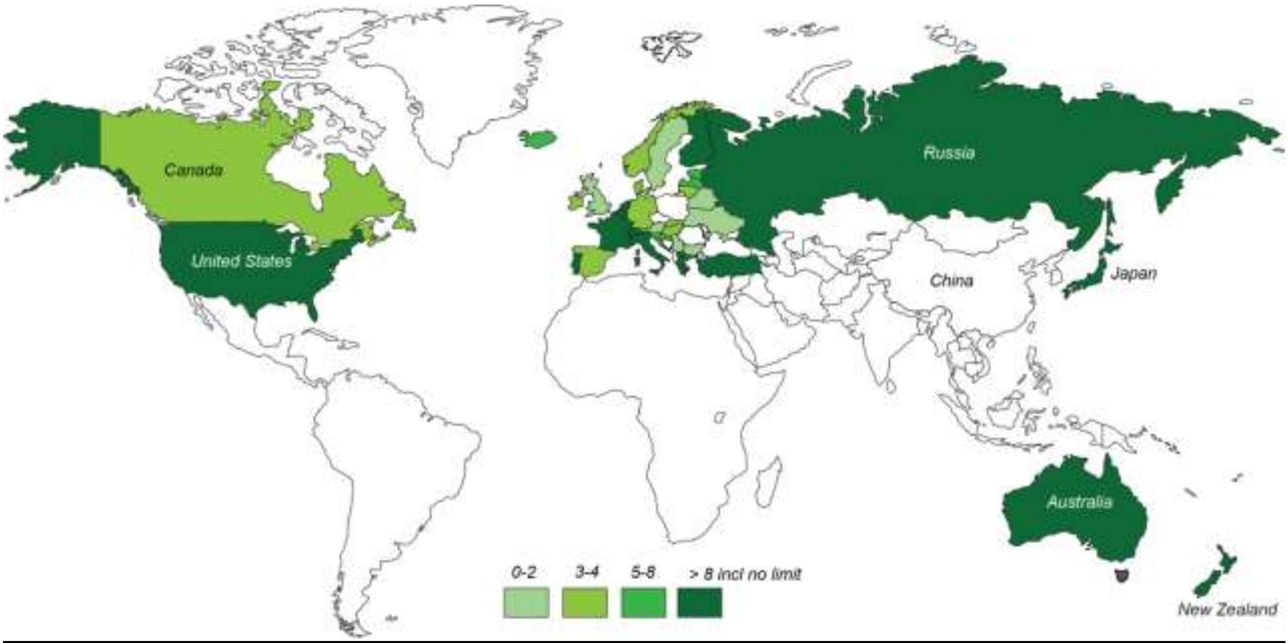


Figure 4. Maximum number of storeys with ***wooden facades*** *in* ***<u>residential</u>*** *buildings acc. to prescriptive requirements;* ***<u>above without</u>*** *sprinklers and* ***<u>below with</u>*** *sprinklers installed.*

Interior applications - Maps

Maximum number of storeys with visible interior wood surfaces in residential buildings

Without sprinklers



With sprinklers

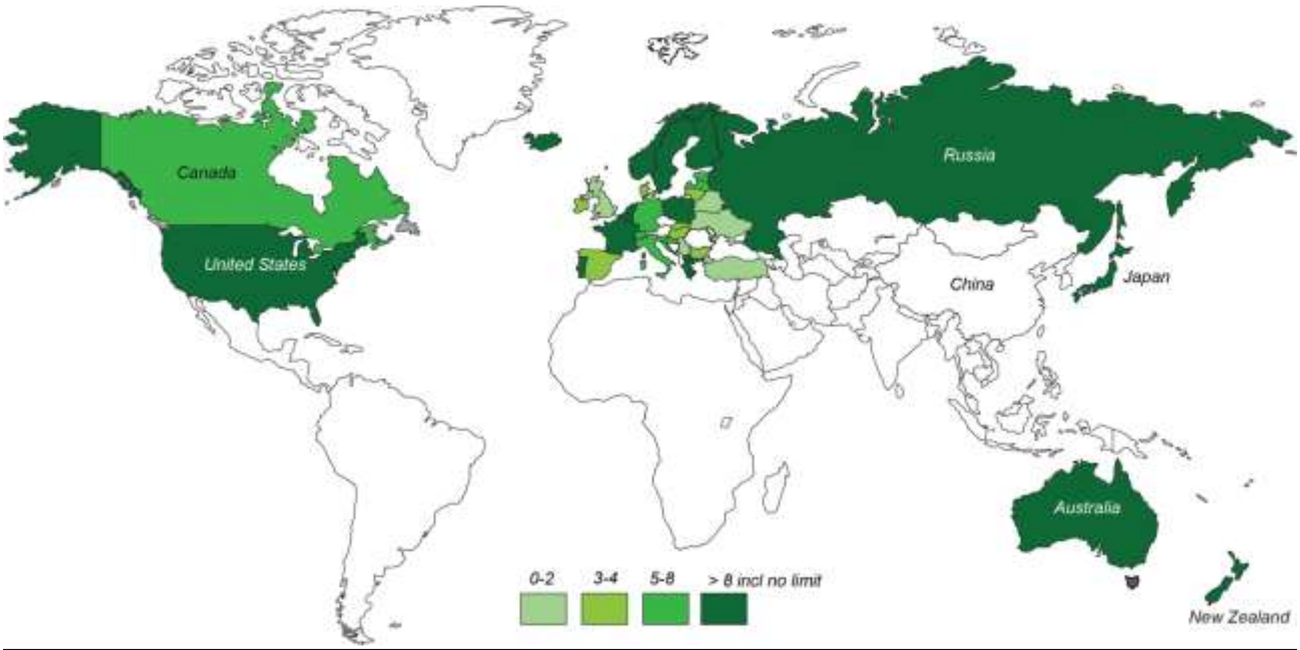


*Figure 5. Maximum number of storeys with visible **interior wood surfaces** (except escape routes) in **residential** buildings acc. to prescriptive requirements; **above without** sprinklers and **below with** sprinklers installed.*

Europe for residential buildings

The differences between European countries are further detailed below.

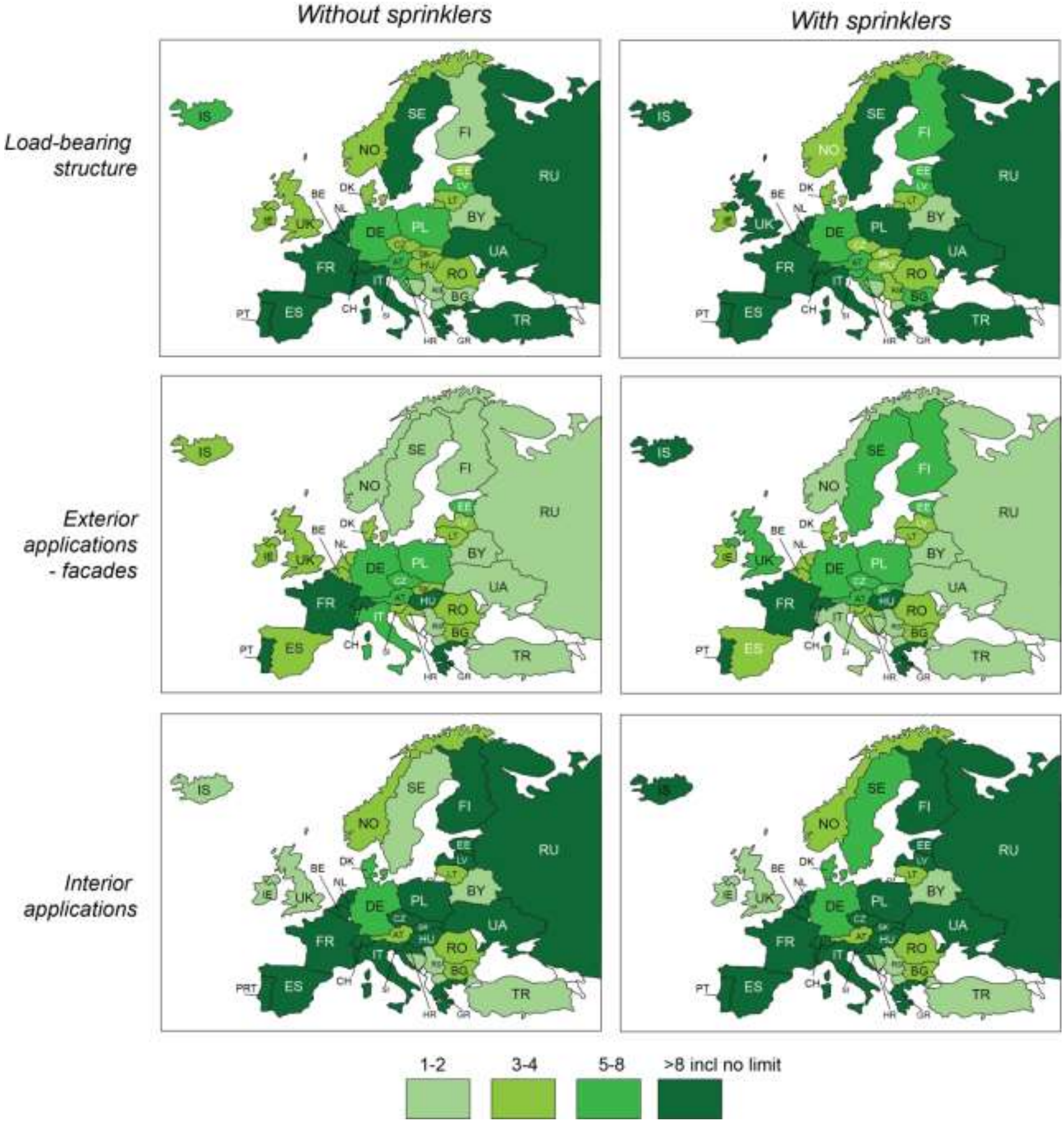


Figure 6. Possibilities to use wood in different applications in Europe.

Conclusions

The differences between countries are still large both in terms of structural use of loadbearing wood structures and the use of visible wood surfaces in interior and exterior applications. Many countries have not yet started to use larger wood constructions despite supplies of forest resources.

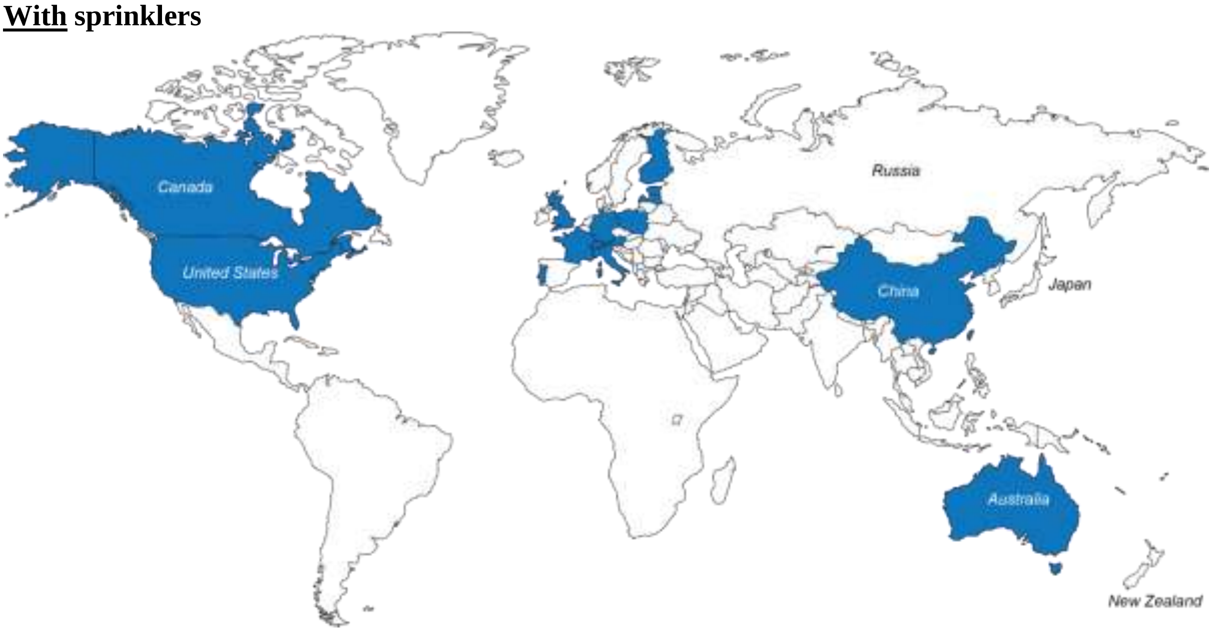
Several countries have no specific regulations, or do not limit the number of storeys in wooden buildings. However, a maximum of eight storeys is often used as a practical limit for wood structures. This limit may be higher for facades, linings and floorings, since these applications may also be used in, for example, concrete structures.

The improvements in maximum number of storeys with load-bearing in wood since 2002 [1] are visualised in Figure 7 below for applications without and with sprinklers.

Changes in number of storeys with <u>load-bearing</u> timber structure since 2002

<u>Without</u> sprinklers

<u>With</u> sprinklers



▭ Changes in number of storeys since 2002

*Figure 7. M**aximum number of storeys** with with load-bearing elements in wood in **<u>residential</u>** buildings acc. to prescriptive requirements have increased in several countries since 2002, as marked in blue; **<u>above without</u>** sprinklers and **<u>below with</u>** sprinklers installed.*

Acknowledgements and thanks

Many colleagues from international networks, e.g. *FSUW Fire Safe Use of Wood* have contributed with national information. Without their input it would not have been possible to compile this survey.
Many thanks to all of you.

Australia	Andrew Dunn
Austria	Irmgard Matzinger, Sylvia Polleres
Belarus	Sergey Palubets, Boris Serkov
Belgium	Yves Martin
Bulgaria	Sotir Gluschkoff
Canada	Christian Dagenais
Croatia	Marija Jelcic Rukavina
China	Peifang Qiu
Czech Rep.	Magdaléna Charvátová, Juraj Olbrimek
Denmark	Frank Markert, Mikkel Baarts Thorsdal
Estonia	Alar Just
Finland	Esko Mikkola
France	Rodolphe Maufront
Germany	Norman Werther
Greece	Dionysis Kolatis
Hungary	Támás Bánky
Iceland	Björn Karlsson, Bödvar Tomasson, David Snorrason
Ireland	Andrew Macilwraith
Italy	Massimo Fragiacomo, Roberto Modena
Japan	Koji Kagiya
Latvia	Edgars Buksans, Edvins Grants
Lithuania	Kęstutis Lukošius
Netherlands	Eric D. de Munck
New Zealand	Colleen Wade, Andy Buchanan
Norway	Vidar Stenstad, Dagfinn Kalheim
N Macedonia	Meri Cvetkovska
Poland	Mazela Bartlomiej, Wojciech Grzeskowiak
Portugal	José M Faria, Miguel Goncalves
Romania	Stefan Timpu
Russian Fed.	Boris B. Serkov, Rosa Aseeva, Eugeniy Kruglov
Serbia	Tatjana Kocetov Misulic
Slovakia	Juraj Olbrimek
Slovenia	Tomaz Hozjan
Spain	Maria Pilar Giraldo
Sweden	Fabian Ardin, Anders Johansson
Switzerland	Michael Klippel
Turkey	Ayfer Dönmez Cavdar
Ukraine	Serhii Pozdieiev
UK/England	Tom Lennon, Octavian Lalu
USA	David Barber

References

[1] Östman B., Rydholm D. National fire regulations in relation to the use of wood in European and some other countries 2002. Trätek Publication 0212044, 2002.

[2] Östman, B. et al, 2010. Fire Safety in Timber Buildings - Technical Guideline for Europe. SP Report 2010:19. Stockholm, Sweden.

[3] Mikkola E., Pilar MG. Bio-based products and national fire safety requirements. COST Action FP1404, Workshop Berlin 2015.

[4] Buchanan A., Östman, B. (Eds.) Fire Safe Use of Wood in Buildings - Global Design Guide. CRC Press, 2022. Available at DOI: 10.1201/9781003190318-1.

Linnaeus University

Post Box 451, SE-351 06 Växjö, Sweden • Phone +46 772-28 80 00 •
E-mail info@lnu.se • Lnu.se