

## Guidelines for Indication of the Amount of Carbon Stored for Wood Used in Buildings

## 1. Purpose

Wood stores carbon absorbed by forests, and promoting the use of wood in buildings and other main domestic applications is expected to contribute to carbon neutrality as a “second forest” in urban and other areas.

In this context, it is an important initiative to show publicly that wood use contributes to the prevention of global warming by displaying the amount of carbon stored for wood used in buildings. This is expected to have a ripple effect on the promotion of wood use. The Guidelines are established to promote increased use of wood by establishing a displaying system that is easy for the public and businesses to understand.

## 2. Scope of application of the Guidelines

The Guidelines provide standard calculation and displaying methods for building owners and construction businesses (hereinafter referred to as “business operators”) to voluntarily and responsibly disclose the amount of carbon stored for wood used in buildings. This disclosure is based on the concept of HWP(\*) regarding wood utilization in buildings, from the perspective of preventing global warming and related considerations. Therefore, the displayed information has no meaning other than indicating the carbon storage amount numerically.

The applicable buildings are buildings that have already been completed (including the state of buildings currently under construction at the time of their completion), and whether a building is newly constructed or not is immaterial so long as all information necessary to calculate the wood used in the building can be obtained. However, temporary structures that are clearly intended for temporary use, such as temporary buildings, are not subject to the Guidelines, given that long-term carbon sequestration is expected in buildings. The carbon stock quantity calculated under the Guidelines represents the carbon stock contained in the wood used in an individual building, and it should be noted that this is different in nature from the HWP values that estimate changes in the carbon stock of wood in buildings at the national level from flow values such as the carbon in wood input to annual construction starts and the carbon emitted during building demolition based on national statistics data.

\* HWP is an abbreviation for harvested wood products, i.e., products made from harvested wood. Following the second commitment period of the Kyoto Protocol, changes in the carbon stock of HWP derived from domestic logs produced through forest management activities can be accounted for as greenhouse gas removals or emissions.

3. Calculation methods for carbon stock (CO<sub>2</sub> equivalents)(1) Formula for carbon stock (CO<sub>2</sub> equivalents)

The formula is as follows.

$$Cs = W \times D \times Cf \times 44/12$$

Cs: Carbon stock (CO<sub>2</sub> equivalent) (t-CO<sub>2</sub>) associated with wood used in buildings (including lumber, laminated wood, plywood, wood-based boards, and other wood-based materials; the same applies hereafter)

W: Amount of wood used in buildings (m<sup>3</sup>) (based on air-dry volume)

D: Wood density (t/m<sup>3</sup>) (ratio of mass in fully dry state to air-dry volume; the same

applies hereafter)

Cf: Wood carbon content (carbon content in the mass of wood in a fully dry state. the same applies hereafter)

Note 1: For calculation, the carbon stock shall be determined by summing the values calculated using wood density and other values corresponding to each category by tree species or by building material (e.g., sawn lumber or plywood).

Note 2: Definitions of the terms used herein are as follows.

Air-dry state: A state in which the moisture content has reached equilibrium with the ambient temperature and humidity. In Japan, the average moisture content is said to be approximately 15%.

Moisture content: The proportion of water contained in wood, defined by the following formula.

$$U = [(W_u - W_0)/W_0] \times 100 [\%]$$

U: Moisture content

$W_u$ : Mass of the wood at moisture content U

$W_0$ : Mass of wood in a fully dry state (moisture content 0%)

Fully dry state: A state of wood with moisture content of 0%.

## (2) Calculation factors

### (i) W: Amount of wood used in buildings

This refers to the amount of wood used in the completed main buildings; it does not include wood used for temporary materials or plywood for concrete formwork that is removed before the buildings are completed.

Also, wood used in buildings does not include wood used for exterior works or soil-improvement materials, etc.; however, if the carbon stock of these is to be displayed, it shall be calculated and displayed separately from the carbon stock of wood used in the buildings.

When determining the amount of domestic logs within the amount of wood used in buildings, for engineered wood products such as laminated wood, CLT (cross laminated timber), and plywood that are composed of different species and contain both domestic and imported logs. For example, the amount of domestic logs shall be identified and calculated by species as necessary by calculating based on the ratio of layers or plies in which domestic logs are used. Also, for wood-based boards, when it can be confirmed that all or a part is derived from domestic logs and the domestic log ratio can be determined, the amount of domestic logs may be calculated by multiplying the total quantity by the domestic log ratio.

### (ii) D: Wood density

The wood density shall be calculated by multiplying the air-dry density (meaning the density in the air-dry state; the same applies hereafter) for each tree species by the conversion factor (see Note 1) representing the ratio of mass in a fully dry state to air-dry volume. For reference, examples of species-specific air-dry density values shown in the literature are presented in Reference 1. Also, if there are publications or other sources that indicate values of wood density, those values may be used. For laminated wood and CLT (cross laminated timber), since they are products made by laminating and bonding sawn laminas, it is acceptable

to use the same wood density as lumber when performing calculations for those products. When using proprietary density data of materials such as laminated wood or CLT that are formed through adhesive bonding, it is necessary that the calculation of that density does not include the mass contribution derived from adhesives or similar substances.

If the density by species is unknown or if calculating by species is difficult, it is permissible to use the density value for Japanese cedar, the species most commonly used in our country.

Additionally, plywood and wood-based boards generally have densities different from lumber; examples of values used in the literature for the densities of these woods are shown in Reference 2. Note that LVL (laminated veneer lumber), like plywood, is a product made by laminating and bonding veneer sheets; therefore, it is acceptable to use the plywood density value for LVL. For plywood, LVL, and wood-based boards, when using proprietary density data, it is necessary that the calculation of those densities does not include the mass contribution derived from adhesives.

Note 1: The conversion factor for air-dry density to the ratio of mass in a fully dried state to volume in air-dry state is 0.87 (100/115), assuming the moisture content of air-dry wood is 15%.

Note 2: When desiring to reflect variations in wood density not only by species but also by origin, etc., for lumber, it shall be possible to calculate more detailed carbon stock quantity by providing evidence regarding the conversion factors used.

(iii) Cf: Wood carbon content

Use carbon content values based on literature or other sources. For reference, examples of carbon content values for building materials are shown in Reference 3.

(3) Organization and preservation of data used in calculations

To ensure that business operators and others can responsibly explain the validity of the data used in calculations, during the period in which carbon stock is indicated it is necessary to appropriately organize and retain the numerical values and supporting documents used in those calculations.

4. Display method

(1) Display content

The items to be displayed shall be as follows, taking into account the concept of HWP while also indicating the significance of wood utilization.

- (i) Name of buildings concerned
- (ii) Total floor area of the buildings
- (iii) Quantity of domestic logs used and carbon stock (CO<sub>2</sub> equivalents) of domestic logs
- (iv) Total quantity of wood used and total wood carbon stock (CO<sub>2</sub> equivalents)
- (v) A statement that the calculation has been performed in accordance with the Guidelines, along with the content of the indication and the purpose for indicating it
- (vi) Information on the basis for the calculations

These items shall be selected from among the above. In addition, the date of calculation and information about the person responsible (for a company, the responsible department, contact information, etc.) should be indicated.

Regarding information related to the basis for calculations, in addition to the literature and other sources used as the basis, when indicating the information in pamphlets or websites, it may also be appropriate to present information such as the back data used to calculate the values displayed so as to make the basis easy to understand.

With respect to indicating information, business operators may present it on a per-building basis or collectively for multiple buildings. When displaying information collectively for multiple buildings, this should be clearly stated outside the indicating area, and information about each individual building should be made easy to view.

In addition to the information indicated in items (i) through (vi), it is possible to separately indicate, for example, the carbon storage capacity of wood used for exterior structures or ground improvement materials. Furthermore, based on the Act on Promotion of Use and Distribution of Legally-harvested Wood and Wood Products (the Clean Wood Act) (Act No. 48 of 2016; hereinafter referred to as the "Clean Wood Act"), it is possible to include a statement indicating that "All wood used is wood whose legality has been confirmed based on the Clean Wood Act." This is possible when it is confirmed that the wood used is derived from trees harvested in compliance with the laws and regulations of Japan or the country of origin, and when legality has been confirmed.

## (2) Examples of displays

Examples of displays are shown in Reference 4.

## (3) Display locations

As for display locations, business operators may present information through methods such as pamphlets or websites, or display information in locations on the buildings or exterior that are easy to see and where the display will be most effective.

## (4) Updating displays

If a building for which carbon stock has been displayed is renovated or otherwise altered such that wood previously used in the buildings is discarded or new wood is used in the building, it is desirable to recalculate the quantity of wood used and carbon stock and to re-display them. When recalculating, the carbon stock associated with discarded wood should be subtracted.

Also, when business operators display information collectively for multiple buildings, it is necessary to appropriately ascertain the renovation and retention/disposition status of all included buildings, and it should be noted that unless recalculations are carried out whenever changes in carbon stock occur, the display will not be appropriate.

Therefore, regarding the date of calculation to be shown in the display, in light of the purpose of updating these displays, it is important to clearly display the point in time when the calculation, including any recalculations, was performed.

## Example values of air-dry density by tree species

In the Revised 4th Edition of the Wood Industry Handbook (supervised by the Forestry and Forest Products Research Institute), the following values are shown as the air-dry density by tree species (g/cm<sup>3</sup>).

Region	Coniferous/ broadleaf classification	Tree species	Air-dry density
Japanese wood	Coniferous wood	Cypress	0.44
Japanese wood	Coniferous wood	Sawara cypress	0.34
Japanese wood	Coniferous wood	Japanese arborvitae (Nezuko, Kurobe)	0.36
Japanese wood	Coniferous wood	Japanese hiba	0.45
Japanese wood	Coniferous wood	Ginkgo	0.47
Japanese wood	Coniferous wood	Japanese fir	0.44
Japanese wood	Coniferous wood	Sakhalin fir (Todomatsu, Akatodomatsu)	0.40
Japanese wood	Coniferous wood	Japanese larch	0.50
Japanese wood	Coniferous wood	Jezo spruce	0.43
Japanese wood	Coniferous wood	Japanese red pine (Akamatsu, Mematsu)	0.52
Japanese wood	Coniferous wood	Japanese white pine	0.45
Japanese wood	Coniferous wood	Japanese black pine (Kuromatsu, Omatsu)	0.54
Japanese wood	Coniferous wood	Japanese Douglas-fir	0.49
Japanese wood	Coniferous wood	Japanese hemlock	0.50
Japanese wood	Coniferous wood	Japanese podocarpus (Inumaki, Honmaki, Kusamaki)	0.54
Japanese wood	Coniferous wood	Japanese umbrella-pine (Kouyamaki, Honmaki)	0.42
Japanese wood	Coniferous wood	Japanese yew (Ichii, Araragi, Onko)	0.51
Japanese wood	Coniferous wood	Japanese torreyia	0.53
Japanese wood	Coniferous wood	Japanese cedar	0.38
Japanese wood	Broadleaf wood	Painted maple	0.65
Japanese wood	Broadleaf wood	Castor aralia (Sen, Harigiri)	0.52
Japanese wood	Broadleaf wood	Monarch birch, Japanese white birch	0.67
Japanese wood	Broadleaf wood	White birch	0.57
Japanese wood	Broadleaf wood	Iron birch	0.90

Region	Coniferous/ broadleaf classification	Tree species	Air-dry density
Japanese wood	Broadleaf wood	Japanese hornbeam	0.73
Japanese wood	Broadleaf wood	Paulownia	0.30
Japanese wood	Broadleaf wood	Boxwood	0.90
Japanese wood	Broadleaf wood	Katsura tree	0.50
Japanese wood	Broadleaf wood	Japanese dogwood	0.61
Japanese wood	Broadleaf wood	Persimmon	0.69
Japanese wood	Broadleaf wood	Japanese chestnut	0.60
Japanese wood	Broadleaf wood	Japanese chinquapin (Ko-jii (Tsubura-jii))	0.54
Japanese wood	Broadleaf wood	Japanese chinquapin (Suda-jii (Ita-jii))	0.61
Japanese wood	Broadleaf wood	Japanese beech	0.65
Japanese wood	Broadleaf wood	Japanese false beech	0.69
Japanese wood	Broadleaf wood	Japanese evergreen oak	0.87
Japanese wood	Broadleaf wood	Japanese stone oak	0.80
Japanese wood	Broadleaf wood	Japanese rough oak	0.96
Japanese wood	Broadleaf wood	Japanese white oak	0.83
Japanese wood	Broadleaf wood	Sawtooth oak	0.84
Japanese wood	Broadleaf wood	Japanese oak (Mizunara, Onara), oak	0.68
Japanese wood	Broadleaf wood	Konara oak	0.79
Japanese wood	Broadleaf wood	Horse chestnut oak	1.07
Japanese wood	Broadleaf wood	Japanese clethra tree	0.90
Japanese wood	Broadleaf wood	Japanese horse chestnut	0.52
Japanese wood	Broadleaf wood	Japanese walnut	0.53
Japanese wood	Broadleaf wood	Sawagurumi	0.45
Japanese wood	Broadleaf wood	Camphor tree	0.52
Japanese wood	Broadleaf wood	Tabu tree	0.65
Japanese wood	Broadleaf wood	Japanese pagoda tree	0.59
Japanese wood	Broadleaf wood	Japanese magnolia	0.49
Japanese wood	Broadleaf wood	Japanese mulberry, Mulberry	0.62
Japanese wood	Broadleaf wood	Manchurian ash (Yachidamo)	0.55
Japanese wood	Broadleaf wood	Manchurian ash (Shioji)	0.53
Japanese wood	Broadleaf wood	Ash tree	0.75
Japanese wood	Broadleaf wood	Aodama	0.71

Region	Coniferous/ broadleaf classification	Tree species	Air-dry density
Japanese wood	Broadleaf wood	Yamato Aodamo	0.72
Japanese wood	Broadleaf wood	Japanese cherry	0.62
Japanese wood	Broadleaf wood	Amur cork tree	0.49
Japanese wood	Broadleaf wood	Japanese poplar, Black cottonwood	0.42
Japanese wood	Broadleaf wood	Japanese linden	0.50
Japanese wood	Broadleaf wood	Japanese elm (Harunire, Akadamo)	0.63
Japanese wood	Broadleaf wood	Japanese zelkova	0.69
North American wood	Coniferous wood	Western hemlock, Lawson cypress	0.47
North American wood	Coniferous wood	Alaska cedar, Alaska cypress	0.51
North American wood	Coniferous wood	Western red cedar, Western arborvitae	0.37
North American wood	Coniferous wood	Pine species (hard pine) (Japanese red/black pine)	0.47
North American wood	Coniferous wood	Pine species (hard pine) (Japanese red/black/white pine)	0.46
North American wood	Coniferous wood	Pine species (soft pine) (Sugar pine)	0.41
North American wood	Coniferous wood	Pine species (soft pine) (Western white pine)	0.42
North American wood	Coniferous wood	Douglas-fir	0.55
North American wood	Coniferous wood	Western hemlock	0.46
North American wood	Coniferous wood	Redwood, Coast redwood	0.46
North American wood	Broadleaf wood	Sugar maple	0.71
North American wood	Broadleaf wood	Hickory	0.82
North American wood	Broadleaf wood	Black walnut	0.63
North American wood	Broadleaf wood	White ash, American ash	0.69
Siberian wood, European wood	Coniferous wood	Japanese red pine	0.45
Tropical hardwood	Coniferous wood	Agathis, Dammar, Kauri	0.46
Tropical hardwood	Coniferous wood	Klinki pine	0.45
Tropical hardwood	Coniferous wood	Kesiya pine, Benguet pine	0.60
Tropical hardwood	Broadleaf wood	Terentang	0.43
Tropical hardwood	Broadleaf wood	Rengas	0.80

Region	Coniferous/ broadleaf classification	Tree species	Air-dry density
Tropical hardwood	Broadleaf wood	Pulai, Milky pine	0.44
Tropical hardwood	Broadleaf wood	Balsa	0.16
Tropical hardwood	Broadleaf wood	Canarium, Kedondong	0.56
Tropical hardwood	Broadleaf wood	Binuang	0.39
Tropical hardwood	Broadleaf wood	Dillenia	0.76
Tropical hardwood	Broadleaf wood	Mersawa	0.60
Tropical hardwood	Broadleaf wood	Merawan	0.69
Tropical hardwood	Broadleaf wood	Giam, Yakal	0.85
Tropical hardwood	Broadleaf wood	New Guinea basswood, Gubas, Sesendok	0.38
Tropical hardwood	Broadleaf wood	Rubber tree, Pará rubber tree	0.65
Tropical hardwood	Broadleaf wood	Malas	0.92
Tropical hardwood	Broadleaf wood	Ramin	0.65
Tropical hardwood	Broadleaf wood	Geronggang	0.47
Tropical hardwood	Broadleaf wood	Belian, Ulin	0.96
Tropical hardwood	Broadleaf wood	Falcata, Sengon laut, Batai, Moluccan sau, White albizia	0.34
Tropical hardwood	Broadleaf wood	Rosewood, Indian/Siamese rosewood	0.85
Tropical hardwood	Broadleaf wood	Kuila, Merbau, Ipil	0.82
Tropical hardwood	Broadleaf wood	Kempas	0.87
Tropical hardwood	Broadleaf wood	Mengarlis	0.83
Tropical hardwood	Broadleaf wood	Pradoo, Oak, New Guinea rosewood	0.65
Tropical hardwood	Broadleaf wood	Jongkong	0.48
Tropical hardwood	Broadleaf wood	Kamerere	0.64
Tropical hardwood	Broadleaf wood	Kalampayan, Kaatoan bangkal, Labula	0.46
Tropical hardwood	Broadleaf wood	Taun, Matoa	0.70
Tropical hardwood	Broadleaf wood	Nyatoh, Nato	0.64
Tropical hardwood	Broadleaf wood	Amberoi	0.40
Tropical hardwood	Broadleaf wood	Mengkulang, Lumbayau	0.76
Tropical hardwood	Broadleaf wood	Melina, Yamane	0.49
Tropical hardwood	Broadleaf wood	Teak	0.69
African wood	Broadleaf wood	Okoume, Gaboon	0.44
African wood	Broadleaf wood	Idigbo, Framire	0.55

Region	Coniferous/ broadleaf classification	Tree species	Air-dry density
African wood	Broadleaf wood	Afara, Limba	0.55
African wood	Broadleaf wood	Afrosmosia, Kokrodua	0.70
African wood	Broadleaf wood	African blackwood, Grenadilla	1.21
African wood	Broadleaf wood	Ovangkol, Ehie	0.74
African wood	Broadleaf wood	Bubinga, Kevazingo	0.88
African wood	Broadleaf wood	Wenge	0.80
African wood	Broadleaf wood	African padauk	0.77
African wood	Broadleaf wood	Sapele	0.65
African wood	Broadleaf wood	African mahogany	0.53
African wood	Broadleaf wood	Avodire	0.58
African wood	Broadleaf wood	Iroko	0.65
African wood	Broadleaf wood	Makore	0.66
African wood	Broadleaf wood	Mansonia	0.68
African wood	Broadleaf wood	Obeche, Wawa, Abachi	0.40
Central and South American wood		Greenheart	1.01
Central and South American wood		Brazilian rosewood	0.98
Central and South American wood		Cocobolo	0.98
Central and South American wood		Kingwood	1.20
Central and South American wood		Honduran rosewood	1.20
Central and South American wood		Cedro, Spanish cedar	0.42
Central and South American wood		Lignum vitae	1.24
Others	Coniferous wood	Taiwan cypress, Taiwan hinoki cypress	0.48
Others	Coniferous wood	Formosan cypress	0.38
Others	Coniferous wood	Caribbean pitch pine	0.75
Others	Coniferous wood	Radiata pine	0.49

## Examples of density values for plywood and wood-based boards

The 2021 Greenhouse Gas Inventory Report of Japan (compiled by the Greenhouse Gas Inventory Office (GIO)) specifies the following density values ( $t/m^3$ ) used for calculating HWP. Note that these values are presented as the ratio of mass in a fully dry state to air-dry volume. Within this report, they are used as the equivalent of D in the calculation formula of the Guidelines.

Wood-based board (particle board)	0.596
Wood-based board (hard fiberboard)	0.788
Wood-based board (medium-density fiberboard)	0.691
Wood-based board (soft fiberboard)	0.159
Plywood	0.542

## Examples of carbon content values for building materials

The 2021 Greenhouse Gas Inventory Report of Japan (compiled by the Greenhouse Gas Inventory Office (GIO)) specifies the following wood carbon content values (t/m<sup>3</sup>) used for calculating HWP. Within this report, they are used as the equivalent of Cf in the calculation formula of the Guidelines.

Lumber	0.5	
Wood-based board (particle board)	0.451	
Wood-based board (hard fiberboard)	0.425	
Wood-based board (medium-density fiberboard)	0.427	
Wood-based board (soft fiberboard)	0.474	
Plywood	0.493	

## Example of displaying the carbon stock of wood used in buildings

Display image for a mid-rise wooden building (example).

Gross floor area: 1,000 m<sup>2</sup>; Total quantity of wood used: 400 m<sup>3</sup> (domestic logs 400 m<sup>3</sup>).

Carbon stock (CO<sub>2</sub> equivalents) in the wood used for xx Building (yy, zz City, Tokyo)

Gross floor area	Quantity of domestic logs used	Carbon stock (CO <sub>2</sub> equivalents) in domestic logs	Total quantity of wood used	Total carbon stock (CO <sub>2</sub> equivalents) in wood used
1,000 m <sup>2</sup>	400 m <sup>3</sup>	273 t-CO <sub>2</sub>	400 m <sup>3</sup>	273 t-CO <sub>2</sub>

This display complies with the Forestry Agency's "Guidelines for Displaying the Carbon Stock of Wood Used in Buildings" (Notification No. 3-Rinseisan-85 by the Director-General of the Forestry Agency dated October 1, 2021), and indicates the carbon stock (CO<sub>2</sub> equivalents) stored in the wood used in the buildings. Wood stores carbon absorbed by forests, and using wood in buildings and other structures is expected to contribute to carbon neutrality as a form of creating a second forest in urban areas.

**Calculation formula**

Volume of wood (m<sup>3</sup>) × Density (t/m<sup>3</sup>) × Carbon content × 44/12 = Carbon stock (CO<sub>2</sub> equivalents) (t-CO<sub>2</sub>)

**Calculation examples**

- Structural materials (lumber): Japanese cedar 240 m<sup>3</sup> × 0.331 t/m<sup>3</sup> × 0.50 × 44/12 = 145.6 t-CO<sub>2</sub>
- Base materials (lumber): Japanese cedar 80 m<sup>3</sup> × 0.331 t/m<sup>3</sup> × 0.50 × 44/12 = 48.5 t-CO<sub>2</sub>
- Structural plywood: Japanese cedar 80 m<sup>3</sup> × 0.542 t/m<sup>3</sup> × 0.493 × 44/12 = 78.4 t-CO<sub>2</sub>

Utilize densities (t/m <sup>3</sup> ) by species and product as identified in the literature.	Carbon content by species and product as identified in the literature.	Convert carbon content to carbon dioxide amount.	Total 273 t-CO <sub>2</sub>
---	--	--	-----------------------------

(Person in charge) xx yy (Contact) TEL: xx-xxxx-xxxx

Note 1: Carbon stock (CO<sub>2</sub> equivalents) should be recorded as an integer by rounding.

Note 2: Use bold borders, color changes, or other appropriate methods to emphasize the desired sections.

Note 3: This table is an example; you may select which items to display.