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## Environmental Product Declaration Hardwood Timber



Environmental Product Declaration (EPD)  
in accordance with ISO 14025 and EN 15804

EPD Registration No. S-P-00561 | Version 1  
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Geographical Scope: Australia



## Environmental Product Declarations

WoodSolutions has developed a suite of EPDs for industry-average, Australian-produced timber products.

These EPDs help to showcase the environmental credentials of Australian wood products. They also provide life cycle data for calculating the impacts of wood products at a building level.

EPDs include:

- #01 Softwood Timber
- #02 Hardwood Timber
- #03 Particleboard
- #04 Medium Density Fibreboard (MDF)
- #05 Plywood

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WoodSolutions is resourced by Forest and Wood Products Australia (FWPA). It is a collaborative effort between FWPA members and levy payers, supported by industry peak bodies and technical associations.

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### Researchers:

Timber Development Association (NSW)  
Suite 604-486 Pacific Highway  
St Leonards NSW 2065

thinkstep Pty Ltd  
25 Jubilee Street  
South Perth WA 6151

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# EPD Details

An Environmental Product Declaration, or EPD, is a standardised and verified way of quantifying the environmental impacts of a product based on a consistent set of rules known as a PCR (Product Category Rules).

Environmental product declarations within the same product category from different programmes may not be comparable. EPDs of construction products may not be comparable if they do not comply with EN 15804.

## Declaration owner:

### Forest and Wood Products Australia Ltd

Web: [www.fwpa.com.au](http://www.fwpa.com.au)

Email: [info@fwpa.com.au](mailto:info@fwpa.com.au)

Post: Level 4, 10-16 Queen Street, Melbourne VIC 3000, Australia



## EPD produced by:

### thinkstep Pty Ltd

Web: [www.thinkstep.com](http://www.thinkstep.com)

Email: [anz@thinkstep.com](mailto:anz@thinkstep.com)

Post: 25 Jubilee Street, South Perth WA 6151, Australia



### Stephen Mitchell, Timber Development Association (NSW) Ltd

Web: [www.tdansw.asn.au](http://www.tdansw.asn.au)

Email: [info@tdansw.asn.au](mailto:info@tdansw.asn.au)

Post: Suite 604-486 Pacific Highway, St Leonards NSW 2065, Australia



## EPD programme operator:

### The Australasian EPD® Programme Ltd

Web: [www.epd-australasia.com](http://www.epd-australasia.com)

Email: [info@epd-australasia.com](mailto:info@epd-australasia.com)

Post: c/o Enviro-Mark Solutions Ltd  
PO Box 69040, Lincoln 7640, New Zealand



## CEN standard EN 15804 served as the core PCR

### PCR:

PCR 2012:01 Construction products and Construction services, Version 2.0, 2015-03-03

### PCR review was conducted by:

The Technical Committee of the International EPD® System.

Chair: Massimo Marino. Contact via [info@environdec.com](mailto:info@environdec.com).

### Independent verification of the declaration and data, according to ISO 14025:

EPD process certification (Internal)

EPD verification (External)

## Third party verifier

### Kimberly Robertson, Catalyst Ltd

Web: [www.catalystnz.co.nz](http://www.catalystnz.co.nz)

Email: [activate@catalystnz.co.nz](mailto:activate@catalystnz.co.nz)

Post: PO Box 37228, Christchurch 8245, New Zealand



## Accredited or approved by: The Australasian EPD® Programme



# Introduction

This Environmental Product Declaration presents the average performance of sawn timber from Australian grown native hardwood processed in Australia by members of Forest and Wood Products Australia (FWPA). It recognises the importance of transparency by providing information on the raw materials, production and environmental impacts of Australian hardwood.

This EPD has been prepared in accordance with ISO 14025:2006, EN 15804:2013, PCR 2012:01 and AEPDP (2015). It covers Australian hardwood products primarily produced in accordance with the following standards:

- AS 2082 Timber – Hardwood – Visually stress-graded for structural purposes
- AS 2796 Timber – Hardwood – Sawn and milled products.

The environmental data presented in this document were largely taken from a survey of industry members conducted by CSIRO on behalf of FWPA (CSIRO 2009). This study covered 22% of total hardwood log production in Australia and 20-30% of total hardwood sawmilling in Australia. Production of the EPD and validation of the data have been facilitated by FWPA with participation of its current sawn hardwood timber producer members listed in Appendix 1. As the number of hardwood sawmills and the volume of sawn hardwood has reduced since CSIRO's study, these members now produce approximately 50% of the total sawn hardwood in Australia.

## Description of the Australian Sawn Hardwood Industry

The Australian sawn hardwood manufacturing industry is an important contributor to the Australian economy – particularly to the regional economies where many producers are based. The overall contribution of the wood and wood products industries to the Australian GDP in 2010-11 was 0.59% (or \$8.3 billion added value) (ABARES 2013). In 2012-13 the Australian hardwood industry produced 744,000 cubic metres of sawn hardwood timber products (ABARES 2014) across 200 different sawmills (Gavran *et al.* 2014).

The distribution of hardwood mills by state is included in Table 1 below. Seven hardwood sawmills have an input capacity greater than 45,000 m<sup>3</sup> of hardwood logs per year.

**Table 1: Hardwood sawmills by Australian state.**

NSW <sup>a</sup>	Vic.	Qld	SA	WA <sup>b</sup>	Tas.	Aust.
63	29	43	0	19	46	200

*a* Includes ACT

*b* includes Northern Territory. Source: Gavran *et al.* 2014



## Use of EPDs within Green Star

This document complies with the requirements for an industry-wide EPD under the Green Building Council of Australia's Green Star rating system given that:

1. It conforms with ISO 14025 and EN 15804.
2. It has been verified by an independent third party.
3. It has at least a cradle-to-gate scope.
4. The participants in the EPD are listed (see Appendix 1).

It may be used by project teams to obtain points under the Materials category of the current *Design & As Built* and *Interiors* rating tools, as well as under the Innovation Challenge category of the legacy Green Star rating tools.

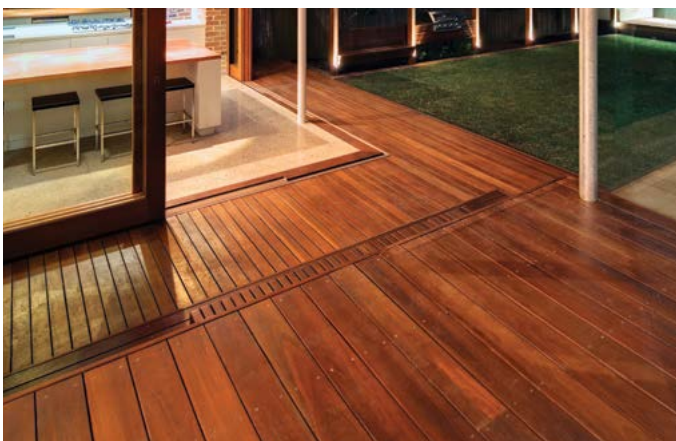
It can also help project teams to conduct a Green Star compliant, whole-of-building, whole-of-life Life Cycle Assessment to obtain additional points under the Materials category of the current *Design & As Built* and *Interiors* rating tools as well as under the Innovation Challenge category of the legacy Green Star rating tools.



Shearer's Quarters by John Wardle Architects, image by Trevor Mein



Bentleigh Secondary College Meditation and Indigenous Culture Centre by dwp suters, image by Emma Cross



House in the Woods by Wilson Architecture Pty Ltd and image by Aaron Pocock Architectural Photography

## Products

This Sector EPD describes the following average products (declared units) manufactured in Australia by the FWPA members listed in Appendix 1:

- *1 m<sup>3</sup> of rough-sawn, kiln-dried hardwood*  
12% moisture content (dry basis), density of 784 kg/m<sup>3</sup>
- *1 m<sup>3</sup> of dressed, kiln-dried hardwood*  
12% moisture content (dry basis), density of 784 kg/m<sup>3</sup>
- *1 m<sup>3</sup> of rough-sawn, green hardwood*  
30% moisture content (dry basis), density of 828 kg/m<sup>3</sup>
- *1 m<sup>3</sup> of dressed, green hardwood*  
30% moisture content (dry basis), density of 828 kg/m<sup>3</sup>

All products consist of 100% Australian native hardwood species grown in native forests.

All timber included in this EPD is untreated. LCA practitioners wishing to model timber treatment themselves can find further information in the Other Environmental Information section.

The declared units above represent an entire product category rather than a specific product from a specific manufacturer. As such, a specific product purchased on the market may have a lesser or greater environmental impact than the average presented in this EPD. Some products may also undergo further processing (e.g. sawing) before being used in a building.

## End Uses

### **Rough-sawn, kiln-dried hardwood**

Hardwood for remanufacturers and 'rough look' kiln-dried structural hardwood.

### **Dressed, kiln-dried hardwood**

Hardwood flooring, decking, cladding, stair treads, kiln-dried structural timber and commercial decking.

### **Rough-sawn, green hardwood**

Green (unseasoned) structural hardwood, fencing, pallet-grade hardwood and landscape timbers.

### **Dressed, green hardwood**

Large dimension veranda posts, green (unseasoned) and commercial decking.

## Representativeness

As the Australian hardwood industry is made up of many small entities, forestry data were collected from three large producers via case studies of southern Tasmania, the Central Highlands of Victoria and northeast NSW, which collectively represented 22% of total production in Australia at the time of the original CSIRO study (2009). For the sawmilling and drying stages, average data from 18 hardwood mills were used, which represented 20-30% of production in Australia in 2009.

Data from the CSIRO study are predominantly for the 2005-06 financial year. At this time, FWPA members produced approximately 30% of all sawn hardwood in Australia. Between 2005-06 and 2012-13, the number of hardwood sawmills in Australia decreased by approximately 60% and the proportion of production from FWPA members increased to almost 50% of the Australian total.

These changes in industry structure have led to a smaller number of larger producers. As it was these larger producers who were surveyed in the original CSIRO study, and as there have been no step changes in Australian forestry or sawmilling over the past decade, TDA and FWPA consider the 2005-06 data to be a good representation of today's conditions. FWPA will monitor for any major changes within the industry during the period of validity of this EPD (2015 to 2020) and update or withdraw this EPD should any such changes occur.

## Industry Classifications

Product	Classification	Code	Category
All	UN CPC Ver.2	31100	Wood, sawn or chipped lengthwise, sliced or peeled, of a thickness exceeding 6 mm
Some rough-sawn, green hardwood	UN CPC Ver.2	31330	Other wood in the rough (including split poles and pickets)
Rough-sawn green, hardwood	ANZSIC 2006	1411	Log sawmilling
Kiln-dried timber and dressed, green hardwood	ANZSIC 2006	1413	Timber resawing and dressing



# LCA Calculation Rules

## System Boundary

This EPD is of the 'cradle-to-gate' type with options. The options include the end-of-life stage, which is modelled through the use of scenarios.

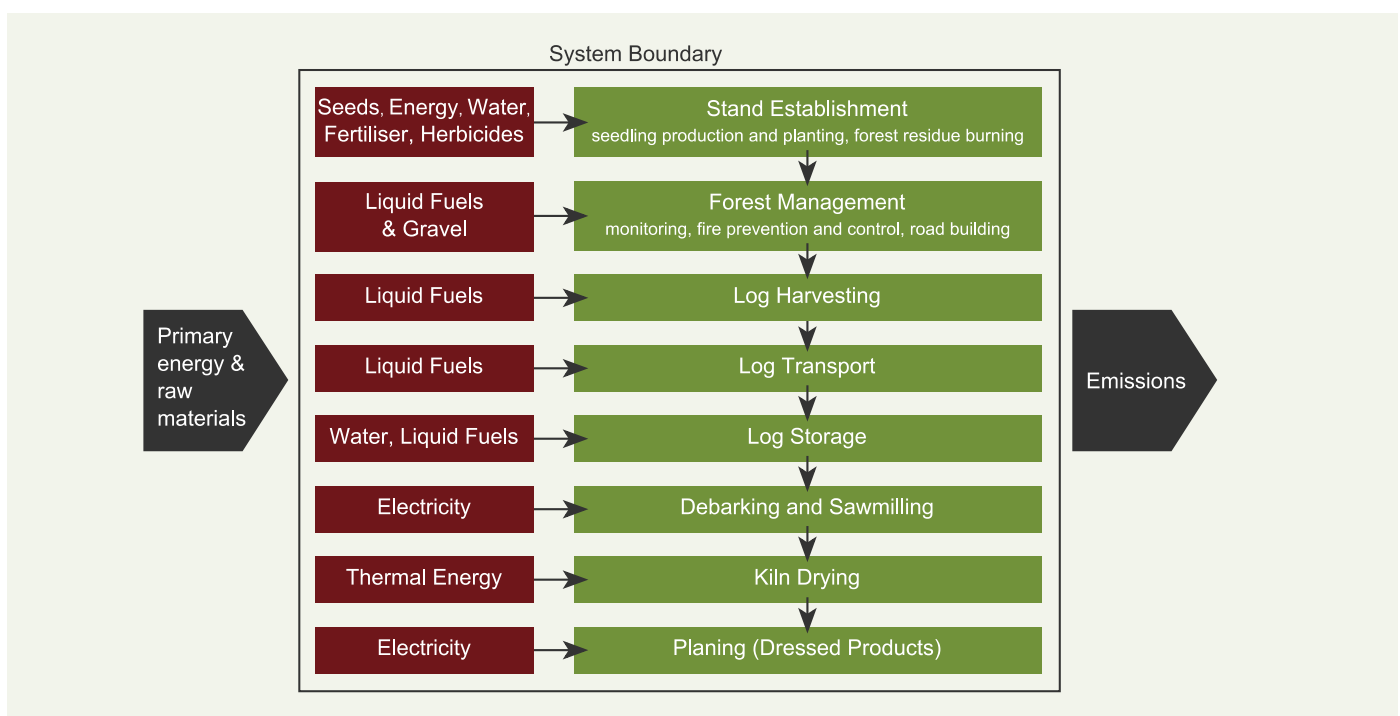
Product stage			Con- struction process stage		Use stage							End-of-life stage				Benefits and loads beyond the system boundary
Raw material supply	Transport of raw materials	Manufacturing	Transport to customer	Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction / demolition	Transport to waste processing	Waste processing	Disposal	Reuse- Recovery- Recycling- potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	X	X	X

Key: X = included in the EPD

ND = not declared (such a declaration shall not be regarded as an indicator result of zero)

## Production

The production stage includes the forestry and sawmilling processes for green sawn timber, kiln drying for kiln-dried timber and planing for dressed timber (green and kiln-dried). Preservative treatment is not included within the scope of this EPD.





When a wood product reaches the end of its useful life, it may either be reused, recycled, landfilled or combusted to produce energy. Landfill is currently the most common end-of-life route for wood products in Australia. Reuse is also common for large dimension hardwoods. All other scenarios are in use in certain regions (Forsythe Consultants 2007; National Timber Product Stewardship Group) and have been included within this EPD.

Each scenario assumes that 100% of the wood is sent to that scenario. To create an end-of-life mix for a given region or end use, the reader should take a weighted sum of these scenarios. Where no data are available, the 'landfill (typical)' scenario should be used for 100% of the waste.

### Landfill

This EPD includes two scenarios for landfill, each with a different value for the degradable organic carbon fraction (DOCf) of wood. The two values are based on bioreactor laboratory research. This experimental work involves the testing of a range of waste types in reactors operated to obtain maximum methane yields. As the laboratory work optimises the conditions for anaerobic decay, the results can be considered as true estimates of the DOCf value that would apply over very long time horizons (Australian Government 2014a, p. 17).

- **Landfill (typical):** DOCf = 0.1%. This is based on bioreactor laboratory research by Wang *et al.* (2011) on blackbutt timber, one of the dominant hardwood species in Australia. This value can be considered as an upper limit for degradation of carbon in solid timber placed in a landfill.
- **Landfill (NGA):** DOCf = 23%. This is the value chosen for Australia's National Greenhouse Accounts (NGA). It was derived from early bioreactor laboratory research from the 1990s (e.g. Barlaz 1998) that investigated the degradability of wood tree branches ground to a fine powder under anaerobic conditions (Australian Government 2014a, p. 17). This value can be considered as an upper limit for degradation of carbon in finely ground timber placed in a landfill.

The impacts associated with the landfill are declared in module C4. All landfill gas that is combusted for energy recovery (module C4) is assumed to occur in a power plant with an electrical conversion efficiency of 36% (Australian Government 2014c, p. 189) and the resulting electricity receives a credit for offsetting average electricity from the Australian grid (module D) in line with EN 16485:2014 (Section 6.3.4.5).

Both landfill scenarios assume the following for carbon emissions:

- Of the gases formed from any degradation of wood in landfill, 50% is methane and 50% is carbon dioxide (Australian Government 2014b).
- All carbon dioxide is released directly to the atmosphere.
- 36% of the methane is captured, based on forecasted average methane capture in Australian landfills by 2020 (Hyder Consulting 2007). Of this, one-quarter (9% of the total) is flared and three-quarters (27% of the total) are used for energy recovery (Carre 2011).
- Of the 64% of methane that is not captured, 10% (6.4% of the total) is oxidised (Australian Government 2014b) and 90% (57.6%) is released to the atmosphere.
- In summary, for every kilogram of carbon converted to landfill gas, 71.2% is released as carbon dioxide and 28.8% is released as methane.

### Energy recovery

This scenario includes shredding and combustion (module C3) with recovered energy offset against average electricity from the Australian grid and thermal energy from natural gas (module D) in line with EN 16485:2014 (Section 6.3.4.5).

## Reuse

The product is assumed to be removed from a building manually and reused with no further processing (i.e. direct reuse). Transport and wastage are excluded and only one reuse cycle is considered. The second life is assumed to be the same (or very similar) to the first, meaning that a credit is given for production of 1 m<sup>3</sup> of primary sawn hardwood in module D. The CO<sub>2</sub> sequestered in wood is assumed to leave the system boundary at module C3 so that future product systems can also claim sequestered CO<sub>2</sub> without double-counting in line with EN 16485:2014 (Section 6.3.4.2). Any further processing, waste or transport would need to be modelled and included separately, e.g. transporting old, large dimension hardwood beams offsite for sawing to make furniture.

## Recycling

Hardwood may be recycled in many different ways. This scenario considers recycling of smaller dimension hardwood that is shredded and effectively downcycled into wood chips. Wood waste is chipped (module C3) and assigned credits relative to the avoided production of woodchips from virgin hardwood (module D). In line with the reuse scenario, the sequestered CO<sub>2</sub> and the energy content of the wood are assumed to leave the system boundary at C3 so that future product systems can also claim these without double-counting (EN 16485:2014 Section 6.3.4.2).

## Key Assumptions

**Energy:** All electricity and thermal energy inputs have been modelled as the Australian average (see thinkstep 2014 for documentation) rather than state-specific energy mixes. This is because the life cycle inventory data from the CSIRO study were aggregated and could not be split by state.

## Cut-off Criteria

Environmental impacts relating to personnel, infrastructure, and production equipment not directly consumed in the process are excluded from the system boundary as per the PCR (IEPDS 2015, Section 6.5.4). Packaging is relatively minimal and has been excluded from the EPD. All other reported data were incorporated and modelled using the best available life cycle inventory data.

## Allocation

**Upstream data:** For refinery products, allocation is done by mass and net calorific value. Inventories for electricity and thermal energy generation include allocation by economic value for some by-products (e.g. gypsum, boiler ash and fly ash). Allocation by energy is applied for co-generation of heat and power. For materials and chemicals, the allocation rule most suitable for the product is applied (see thinkstep 2014).

**Co-products (e.g. sawn wood and sawdust from milling):** As the difference in economic value of the co-products is high (>25% as per EN 15804, Section 6.4.3.2), allocation has been done by economic value.

## Background Data

Data for all energy inputs, transport processes and raw materials are from GaBi Databases 2014 (thinkstep 2014). Most datasets have a reference year between 2011 and 2013 and all fall within the 10-year limit allowable for generic data under EN 15804 (Section 6.3.7).

As data for planing were not available within the original CSIRO study, the average of the two hardwood planing datasets for hardwood timber from the Consortium for Research on Renewable Industrial Materials has been applied (CORRIM 2009, 2010).

All Australian electricity is assumed to be the 2011 national average with a Global Warming Potential of 1,004 g CO<sub>2e</sub>/kWh, made up of 90% fossil fuel energy (46.6% hard coal, 21.9% lignite, 19.7% natural gas, 1.6% heavy fuel oil, 0.2% coal gases) and 10% renewable energy (6.7% hydro, 2.3% wind, 0.4% biomass, 0.4% biogas, 0.3% photovoltaic) (thinkstep 2014).

# EPD Results

Note: these tables show the impacts associated with production and end-of-life. Any potential credits to future products from recycling or energy recovery are presented in the Other Environmental Information section.

## Environmental Impact Indicators

An introduction to each environmental impact indicator is provided below. The best-known effect of each indicator is listed to the right of its name.

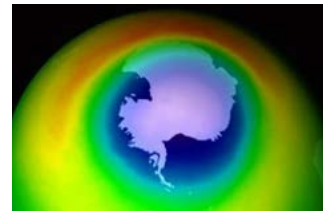
### Global Warming Potential (GWP) → Climate Change

A measure of greenhouse gas emissions, such as carbon dioxide and methane. These emissions increase absorption of radiation emitted by the earth, intensifying the natural greenhouse effect. Contributions to GWP can come from either fossil or biogenic sources, e.g. burning fossil fuels or burning wood. GWP is reported both including biogenic carbon (GWPIB) and excluding biogenic carbon (GWPEB).



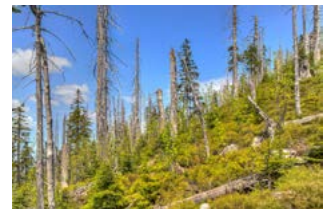
### Ozone Depletion Potential (ODP) → Ozone Hole

A measure of air emissions that contribute to the depletion of the stratospheric ozone layer, causing higher levels of ultraviolet B (UVB) to reach the earth's surface with detrimental effects on humans, animals and plants.



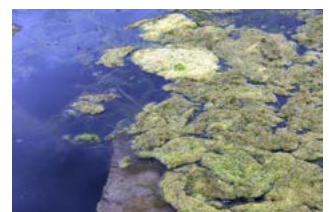
### Acidification Potential (AP) → Acid Rain

A measure of emissions that cause acidifying effects to the environment. Acidification potential is a measure of a molecule's capacity to increase the hydrogen ion (H<sup>+</sup>) concentration in the presence of water, thus decreasing the pH value. Potential effects include fish mortality, forest decline and the deterioration of building materials.



### Eutrophication Potential (EP) → Algal Blooms

A measure of nutrient enrichment that may cause an undesirable shift in species composition and elevated biomass production in both aquatic and terrestrial ecosystems. It includes potential impacts of excessively high levels of macronutrients, the most important of which are nitrogen (N) and phosphorus (P).



### Photochemical Ozone Creation Potential (POCP) → Smog

A measure of emissions of precursors that contribute to ground level smog formation (mainly ozone O<sub>3</sub>), produced by the reaction of VOCs and carbon monoxide in the presence of nitrogen oxides under the influence of UV light. Ground level ozone may be harmful to human and ecosystem health and may also damage crops.



### Abiotic Depletion Potential → Resource Consumption

The consumption of non-renewable resources leads to a decrease in the future availability of the functions supplied by these resources. Depletion of mineral resource elements (ADPE) and non-renewable fossil energy resources (ADPF) are reported separately.



**Table 2: Environmental impacts, 1 m<sup>3</sup> of rough-sawn, kiln-dried hardwood.**

	Production	Landfill (typical)	Landfill (NGA)	Energy recovery	Reuse	Recycling
Parameter [Unit]	A1-A3	C4	C4	C3	C3	C3
GWPIB [kg CO <sub>2</sub> -eq.]	-8.46E+02	5.89E+01	1.04E+03	1.29E+03	1.28E+03	1.29E+03
GWPEB [kg CO <sub>2</sub> -eq.]	4.38E+02	5.90E+01	7.53E+02	8.01E+00	0.00E+00	8.01E+00
ODP [kg CFC11-eq.]	6.17E-10	5.29E-10	5.29E-10	2.54E-10	0.00E+00	2.54E-10
AP [kg SO <sub>2</sub> -eq.]	2.62E+00	1.89E-01	2.54E-01	1.27E+00	0.00E+00	5.09E-02
EP [kg PO <sub>4</sub> <sup>3-</sup> -eq.]	5.89E-01	2.47E-02	4.08E-02	2.55E-01	0.00E+00	1.20E-02
POCP [kg C <sub>2</sub> H <sub>4</sub> -eq.]	2.36E+00	1.71E-02	2.09E-01	1.36E-01	0.00E+00	5.38E-03
ADPE [kg Sb-eq.]	3.89E-05	1.13E-05	1.13E-05	1.34E-07	0.00E+00	1.34E-07
ADPF [MJ]	3.67E+03	8.53E+02	8.53E+02	1.03E+02	0.00E+00	1.03E+02

**Table 3: Environmental impacts, 1 m<sup>3</sup> of dressed, kiln-dried hardwood.**

	Production	Landfill (typical)	Landfill (NGA)	Energy recovery	Reuse	Recycling
Parameter [Unit]	A1-A3	C4	C4	C3	C3	C3
GWPIB [kg CO <sub>2</sub> -eq.]	-6.73E+02	5.89E+01	1.04E+03	1.29E+03	1.28E+03	1.29E+03
GWPEB [kg CO <sub>2</sub> -eq.]	6.10E+02	5.90E+01	7.53E+02	8.01E+00	0.00E+00	8.01E+00
ODP [kg CFC11-eq.]	1.21E-09	5.29E-10	5.29E-10	2.54E-10	0.00E+00	2.54E-10
AP [kg SO <sub>2</sub> -eq.]	3.58E+00	1.89E-01	2.54E-01	1.27E+00	0.00E+00	5.09E-02
EP [kg PO <sub>4</sub> <sup>3-</sup> -eq.]	7.78E-01	2.47E-02	4.08E-02	2.55E-01	0.00E+00	1.20E-02
POCP [kg C <sub>2</sub> H <sub>4</sub> -eq.]	3.05E+00	1.71E-02	2.09E-01	1.36E-01	0.00E+00	5.38E-03
ADPE [kg Sb-eq.]	5.14E-05	1.13E-05	1.13E-05	1.34E-07	0.00E+00	1.34E-07
ADPF [MJ]	5.24E+03	8.53E+02	8.53E+02	1.03E+02	0.00E+00	1.03E+02

**Table 4: Environmental impacts, 1 m<sup>3</sup> of rough-sawn, green hardwood.**

	Production	Landfill (typical)	Landfill (NGA)	Energy recovery	Reuse	Recycling
Parameter [Unit]	A1-A3	C4	C4	C3	C3	C3
GWPIB [kg CO <sub>2</sub> -eq.]	-7.88E+02	5.91E+01	9.37E+02	1.20E+03	1.17E+03	1.18E+03
GWPEB [kg CO <sub>2</sub> -eq.]	3.80E+02	5.92E+01	6.78E+02	2.95E+01	0.00E+00	8.46E+00
ODP [kg CFC11-eq.]	4.39E-10	5.30E-10	5.30E-10	3.86E-10	0.00E+00	2.68E-10
AP [kg SO <sub>2</sub> -eq.]	2.30E+00	1.91E-01	2.48E-01	1.22E+00	0.00E+00	5.38E-02
EP [kg PO <sub>4</sub> <sup>3-</sup> -eq.]	5.25E-01	2.50E-02	3.94E-02	2.41E-01	0.00E+00	1.27E-02
POCP [kg C <sub>2</sub> H <sub>4</sub> -eq.]	2.06E+00	1.73E-02	1.88E-01	1.34E-01	0.00E+00	5.69E-03
ADPE [kg Sb-eq.]	2.37E-05	1.13E-05	1.13E-05	1.39E-06	0.00E+00	1.41E-07
ADPF [MJ]	3.13E+03	8.54E+02	8.54E+02	3.93E+02	0.00E+00	1.09E+02



**Table 5: Environmental impacts, 1 m<sup>3</sup> of dressed, green hardwood.**

	Production	Landfill (typical)	Landfill (NGA)	Energy recovery	Reuse	Recycling
Parameter [Unit]	A1-A3	C4	C4	C3	C3	C3
GWPIB [kg CO <sub>2</sub> -eq.]	-6.32E+02	5.91E+01	9.37E+02	1.20E+03	1.17E+03	1.18E+03
GWPEB [kg CO <sub>2</sub> -eq.]	5.35E+02	5.92E+01	6.78E+02	2.95E+01	0.00E+00	8.46E+00
ODP [kg CFC11-eq.]	9.84E-10	5.30E-10	5.30E-10	3.86E-10	0.00E+00	2.68E-10
AP [kg SO <sub>2</sub> -eq.]	3.17E+00	1.91E-01	2.48E-01	1.22E+00	0.00E+00	5.38E-02
EP [kg PO <sub>4</sub> <sup>3-</sup> -eq.]	6.96E-01	2.50E-02	3.94E-02	2.41E-01	0.00E+00	1.27E-02
POCP [kg C <sub>2</sub> H <sub>4</sub> -eq.]	2.67E+00	1.73E-02	1.88E-01	1.34E-01	0.00E+00	5.69E-03
ADPE [kg Sb-eq.]	3.17E-05	1.13E-05	1.13E-05	1.39E-06	0.00E+00	1.41E-07
ADPF [MJ]	4.54E+03	8.54E+02	8.54E+02	3.93E+02	0.00E+00	1.09E+02

## Resource Use

**Table 6: Resource use, 1 m<sup>3</sup> of rough-sawn, kiln-dried hardwood.**

	Production	Landfill (typical)	Landfill (NGA)	Energy recovery	Reuse	Recycling
Parameter [Unit]	A1-A3	C4	C4	C3	C3	C3
PERE [MJ]	2.38E+03	4.27E+01	4.27E+01	1.32E+04	0.00E+00	2.60E+00
PERM [MJ]	1.32E+04	0.00E+00	0.00E+00	-1.32E+04	-1.32E+04	-1.32E+04
PERT [MJ]	1.56E+04	4.27E+01	4.27E+01	2.52E+00	-1.32E+04	-1.32E+04
PENRE [MJ]	3.68E+03	8.71E+02	8.71E+02	1.03E+02	0.00E+00	1.03E+02
PENRM [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT [MJ]	3.68E+03	8.71E+02	8.71E+02	1.03E+02	0.00E+00	1.03E+02
SM [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FWB [m <sup>3</sup> ]	1.44E+00	6.51E-03	1.16E-01	8.22E-01	0.00E+00	2.14E-03
FWG [m <sup>3</sup> ]	1.47E+03	2.58E-01	2.58E-01	4.10E-02	0.00E+00	4.10E-02
FWT [m <sup>3</sup> ]	1.47E+03	2.64E-01	3.74E-01	8.63E-01	0.00E+00	4.31E-02

*PERE* = Use of renewable primary energy excluding renewable primary energy resources used as raw materials;

*PERM* = Use of renewable primary energy resources used as raw materials; *PERT* = Total use of renewable primary energy resources;

*PENRE* = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials;

*PENRM* = Use of non-renewable primary energy resources used as raw materials; *PENRT* = Total use of non-renewable primary energy resources;

*SM* = Use of secondary material; *RSF* = Use of renewable secondary fuels; *NRSF* = Use of non-renewable secondary fuels;

*FWB* = Use of net blue water, i.e. water from rivers, lakes and aquifers; *FWG* = Use of net green water, i.e. rain water;

*FWT* = Total use of net fresh water

**Table 7: Resource use, 1 m<sup>3</sup> of dressed, kiln-dried hardwood.**

	Production	Landfill (typical)	Landfill (NGA)	Energy recovery	Reuse	Recycling
Parameter [Unit]	A1-A3	C4	C4	C3	C3	C3
PERE [MJ]	3.10E+03	4.27E+01	4.27E+01	1.32E+04	0.00E+00	2.60E+00
PERM [MJ]	1.32E+04	0.00E+00	0.00E+00	-1.32E+04	-1.32E+04	-1.32E+04
PERT [MJ]	1.63E+04	4.27E+01	4.27E+01	2.52E+00	-1.32E+04	-1.32E+04
PENRE [MJ]	5.26E+03	8.71E+02	8.71E+02	1.03E+02	0.00E+00	1.03E+02
PENRM [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT [MJ]	5.26E+03	8.71E+02	8.71E+02	1.03E+02	0.00E+00	1.03E+02
SM [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FWB [m <sup>3</sup> ]	2.10E+00	6.51E-03	1.16E-01	8.22E-01	0.00E+00	2.14E-03
FWG [m <sup>3</sup> ]	1.90E+03	2.58E-01	2.58E-01	4.10E-02	0.00E+00	4.10E-02
FWT [m <sup>3</sup> ]	1.90E+03	2.64E-01	3.74E-01	8.63E-01	0.00E+00	4.31E-02

**Table 8: Resource use, 1 m<sup>3</sup> of rough-sawn, green hardwood.**

	Production	Landfill (typical)	Landfill (NGA)	Energy recovery	Reuse	Recycling
Parameter [Unit]	A1-A3	C4	C4	C3	C3	C3
PERE [MJ]	1.49E+02	4.28E+01	4.28E+01	1.24E+04	0.00E+00	2.70E+00
PERM [MJ]	1.18E+04	0.00E+00	0.00E+00	-1.18E+04	-1.18E+04	-1.18E+04
PERT [MJ]	1.19E+04	4.28E+01	4.28E+01	6.66E+02	-1.18E+04	-1.18E+04
PENRE [MJ]	3.14E+03	8.73E+02	8.73E+02	3.95E+02	0.00E+00	1.09E+02
PENRM [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT [MJ]	3.14E+03	8.73E+02	8.73E+02	3.95E+02	0.00E+00	1.09E+02
SM [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FWB [m <sup>3</sup> ]	1.21E+00	6.70E-03	1.04E-01	8.27E-01	0.00E+00	2.26E-03
FWG [m <sup>3</sup> ]	1.33E+03	2.61E-01	2.61E-01	1.76E+00	0.00E+00	4.33E-02
FWT [m <sup>3</sup> ]	1.34E+03	2.68E-01	3.66E-01	2.58E+00	0.00E+00	4.55E-02

**Table 9: Resource use, 1 m<sup>3</sup> of dressed, green hardwood.**

	Production	Landfill (typical)	Landfill (NGA)	Energy recovery	Reuse	Recycling
Parameter [Unit]	A1-A3	C4	C4	C3	C3	C3
PERE [MJ]	2.25E+02	4.28E+01	4.28E+01	1.24E+04	0.00E+00	2.70E+00
PERM [MJ]	1.18E+04	0.00E+00	0.00E+00	-1.18E+04	-1.18E+04	-1.18E+04
PERT [MJ]	1.20E+04	4.28E+01	4.28E+01	6.66E+02	-1.18E+04	-1.18E+04
PENRE [MJ]	4.56E+03	8.73E+02	8.73E+02	3.95E+02	0.00E+00	1.09E+02
PENRM [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT [MJ]	4.56E+03	8.73E+02	8.73E+02	3.95E+02	0.00E+00	1.09E+02
SM [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FWB [m <sup>3</sup> ]	1.80E+00	6.70E-03	1.04E-01	8.27E-01	0.00E+00	2.26E-03
FWG [m <sup>3</sup> ]	1.72E+03	2.61E-01	2.61E-01	1.76E+00	0.00E+00	4.33E-02
FWT [m <sup>3</sup> ]	1.73E+03	2.68E-01	3.66E-01	2.58E+00	0.00E+00	4.55E-02

**Table 10: Waste categories, 1 m<sup>3</sup> of rough-sawn, kiln-dried hardwood.**

	Production	Landfill (typical)	Landfill (NGA)	Energy recovery	Reuse	Recycling
Parameter [Unit]	A1-A3	C4	C4	C3	C3	C3
HWD [kg]	6.97E-04	1.46E-04	1.46E-04	1.78E-05	0.00E+00	1.78E-05
NHWD [kg]	3.36E+01	7.87E+02	4.98E+02	6.08E-03	0.00E+00	6.08E-03
RWD [kg]	6.08E-03	7.31E-03	7.31E-03	1.61E-05	0.00E+00	1.61E-05
CRU [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.84E+02	0.00E+00
MFR [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.84E+02
MER [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE [MJ]	0.00E+00	0.00E+00	2.63E+02	4.34E+03	0.00E+00	0.00E+00
EET [MJ]	0.00E+00	0.00E+00	0.00E+00	4.34E+03	0.00E+00	0.00E+00

*HWD* = Hazardous waste disposed; *NHWD* = Non-hazardous waste disposed; *RWD* = Radioactive waste disposed; *CRU* = Components for reuse; *MFR* = Materials for recycling; *MER* = Materials for energy recovery; *EEE* = Exported electrical energy; *EET* = Exported thermal energy

**Table 11: Waste categories, 1 m<sup>3</sup> of dressed, kiln-dried hardwood.**

	Production	Landfill (typical)	Landfill (NGA)	Energy recovery	Reuse	Recycling
Parameter [Unit]	A1-A3	C4	C4	C3	C3	C3
HWD [kg]	9.90E-04	1.46E-04	1.46E-04	1.78E-05	0.00E+00	1.78E-05
NHWD [kg]	4.35E+01	7.87E+02	4.98E+02	6.08E-03	0.00E+00	6.08E-03
RWD [kg]	8.00E-03	7.31E-03	7.31E-03	1.61E-05	0.00E+00	1.61E-05
CRU [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.84E+02	0.00E+00
MFR [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.84E+02
MER [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE [MJ]	0.00E+00	0.00E+00	2.63E+02	4.34E+03	0.00E+00	0.00E+00
EET [MJ]	0.00E+00	0.00E+00	0.00E+00	4.34E+03	0.00E+00	0.00E+00

**Table 12: Waste categories, 1 m<sup>3</sup> of rough, sawn green hardwood.**

	Production	Landfill (typical)	Landfill (NGA)	Energy recovery	Reuse	Recycling
Parameter [Unit]	A1-A3	C4	C4	C3	C3	C3
HWD [kg]	5.92E-04	1.47E-04	1.47E-04	1.24E-03	0.00E+00	1.88E-05
NHWD [kg]	2.20E+01	8.31E+02	5.74E+02	6.59E-01	0.00E+00	6.42E-03
RWD [kg]	4.32E-03	7.31E-03	7.31E-03	7.28E-04	0.00E+00	1.70E-05
CRU [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.28E+02	0.00E+00
MFR [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.28E+02
MER [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE [MJ]	0.00E+00	0.00E+00	2.35E+02	3.46E+03	0.00E+00	0.00E+00
EET [MJ]	0.00E+00	0.00E+00	0.00E+00	3.46E+03	0.00E+00	0.00E+00

**Table 13: Waste categories, 1 m<sup>3</sup> of dressed, green hardwood.**

	Production	Landfill (typical)	Landfill (NGA)	Energy recovery	Reuse	Recycling
Parameter [Unit]	A1-A3	C4	C4	C3	C3	C3
HWD [kg]	8.53E-04	1.47E-04	1.47E-04	1.24E-03	0.00E+00	1.88E-05
NHWD [kg]	2.86E+01	8.31E+02	5.74E+02	6.59E-01	0.00E+00	6.42E-03
RWD [kg]	5.72E-03	7.31E-03	7.31E-03	7.28E-04	0.00E+00	1.70E-05
CRU [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.28E+02	0.00E+00
MFR [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.28E+02
MER [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE [MJ]	0.00E+00	0.00E+00	2.35E+02	3.46E+03	0.00E+00	0.00E+00
EET [MJ]	0.00E+00	0.00E+00	0.00E+00	3.46E+03	0.00E+00	0.00E+00

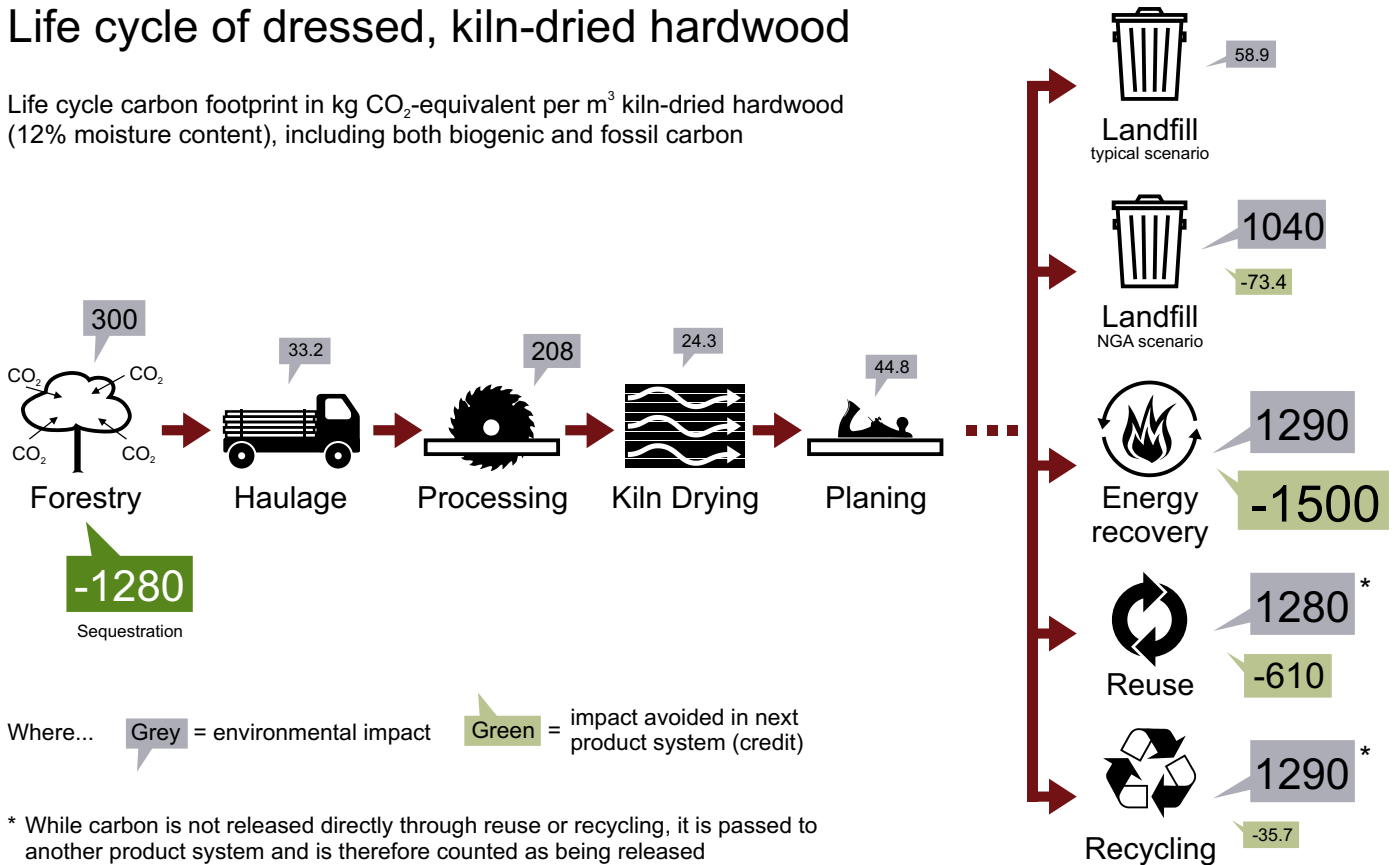


# Interpretation

## Understanding the Life Cycle of Hardwood Timber

### Life cycle of dressed, kiln-dried hardwood

Life cycle carbon footprint in kg CO<sub>2</sub>-equivalent per m<sup>3</sup> kiln-dried hardwood (12% moisture content), including both biogenic and fossil carbon



## Variation in Results

The data in this EPD are an average from multiple producers; however, there can be considerable variation between producers. Please contact your timber supplier if you require data on a specific product from that supplier.

## Carbon Dioxide Sequestration

During growth, trees absorb carbon dioxide (CO<sub>2</sub>) from the atmosphere through the process of photosynthesis and convert this into carbon-based compounds that constitute various components of a tree, including wood. On average, half the dry weight of all wood is made up of the element carbon. An Australian study (Gifford 2000) confirmed that 50±2% of the dry weight of the wood of native species and non-native *Pinus radiata* is carbon.

The CO<sub>2</sub> sequestered per cubic metre of wood was calculated using the formula specified in European standard EN 16449:2014:

$$P_{CO_2} = \frac{44}{12} \times cf \times \frac{\rho_w \times V_w}{1 + \frac{\omega}{100}}$$

Where:

- $P_{CO_2}$  is the biogenic carbon sequestered in the wood that can be oxidised to a carbon dioxide emission to air
- $\frac{44}{12}$  is the molecular weight of carbon dioxide divided by the atomic weight of carbon
- $cf$  is the carbon fraction of oven dry mass of woody biomass (0.5 is the default value)
- $\omega$  is the moisture content of the product on a dry basis (12% for kiln-dried, sawn hardwood and 30% for green, sawn hardwood)
- $\rho_w$  is the density of woody biomass at that moisture content ( $kg/m^3$ ) ( $784 kg/m^3$  for kiln-dried or  $828 kg/m^3$  for green, based on weighted averages)
- $V_w$  is the volume of the solid wood product at that moisture content ( $m^3$ ) (1 is the default value)

All major Australian production forests and plantations are independently certified to one or both of the internationally recognised forest management certification systems: the Australian Standard for Sustainable Forest Management (AS 4708), which is recognised under the Programme for the Endorsement of Forest Certification (PEFC), and/or one of the Forest Stewardship Council's (FSC®) interim forest management standards. It is therefore appropriate to include biogenic CO<sub>2</sub> sequestration in this EPD in line with EN 16485 (Section 6.3.4.2). For more information on certification by forest owner or manager please see [www.forestrystandard.org.au/find-certified/certified-forest-managers](http://www.forestrystandard.org.au/find-certified/certified-forest-managers) and [info.fsc.org/certificate.php](http://info.fsc.org/certificate.php).

## Water Consumption

Freshwater consumption is included in this EPD as required by PCR 2012:01. It has been split into blue water (i.e. water from lakes, rivers and aquifers) and green water (i.e. rain water). Blue water is usually metered and consumption is therefore based on physical measurements.

Green water consumption is difficult to quantify. The data included in this EPD are based on calculated differences in water flow between conservation forests and production forests from the original CSIRO LCI study (CSIRO 2009). CSIRO found an average difference of 15% between these forest types and applied this to rainfall data to estimate green water consumption. The reader should be aware that these figures are uncertain and also provide no information about the impacts of water consumption, such as relative water stress in a given catchment where forest is harvested.

## Changes to *Life Cycle Inventory of Australian Forestry and Wood Products*

The data in this EPD have been based on the *Life Cycle Inventory of Australian Forestry and Wood Products* (CSIRO 2009) with the underlying LCA models completely rebuilt in the GaBi LCA software and aligned with the modular structure of EN 15804. Through this process, assumptions in the CSIRO study have been re-examined, discrepancies corrected, consistency improved and data gaps filled. As such, the results in this EPD do not completely match those in the original CSIRO study. Furthermore, all end-of-life scenarios are new and were developed specifically for all the Australian timber and wood product EPDs produced in this series.

# Other Environmental Information

## Module D: Recycling, Reuse and Recovery Potentials

Table 14: Module D, 1 m<sup>3</sup> of rough-sawn, kiln-dried hardwood.

Parameter [Unit]	Landfill (typical)	Landfill (NGA)	Energy recovery	Reuse	Recycling
<b>Environmental Impact</b>					
GWPIB [kg CO <sub>2</sub> -eq.]	0.00E+00	-7.34E+01	-1.50E+03	-4.38E+02	-3.57E+01
GWPEB [kg CO <sub>2</sub> -eq.]	0.00E+00	-7.35E+01	-1.50E+03	-4.38E+02	-3.60E+01
ODP [kg CFC11-eq.]	0.00E+00	-5.67E-11	-9.50E-10	-6.17E-10	-4.37E-10
AP [kg SO <sub>2</sub> -eq.]	0.00E+00	-3.22E-01	-5.72E+00	-2.62E+00	-6.43E-01
EP [kg PO <sub>4</sub> <sup>3-</sup> -eq.]	0.00E+00	-2.70E-02	-5.48E-01	-5.89E-01	-1.23E-01
POCP [kg C <sub>2</sub> H <sub>4</sub> -eq.]	0.00E+00	-1.74E-02	-3.26E-01	-2.36E+00	-1.23E-01
ADPE [kg Sb-eq.]	0.00E+00	-1.93E-06	-4.93E-05	-3.89E-05	-2.67E-06
ADPF [MJ]	0.00E+00	-8.28E+02	-1.85E+04	-3.67E+03	-3.76E+02
<b>Resource Use</b>					
PERE [MJ]	0.00E+00	-5.43E+01	-8.97E+02	-2.38E+03	-2.48E+03
PERM [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT [MJ]	0.00E+00	-5.43E+01	-8.97E+02	-2.38E+03	-2.48E+03
PENRE [MJ]	0.00E+00	-8.29E+02	-1.85E+04	-3.68E+03	-3.83E+02
PENRM [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT [MJ]	0.00E+00	-8.29E+02	-1.85E+04	-3.68E+03	-3.83E+02
SM [kg]	0.00E+00	0.00E+00	0.00E+00	7.84E+02	7.84E+02
RSF [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FWB [m <sup>3</sup> ]	0.00E+00	-4.09E-01	-6.75E+00	-1.44E+00	-5.72E-01
FWG [m <sup>3</sup> ]	0.00E+00	-4.35E-02	-7.32E-01	-1.47E+03	-3.40E+01
FWT [m <sup>3</sup> ]	0.00E+00	-4.53E-01	-7.48E+00	-1.47E+03	-3.46E+01
<b>Wastes and Outputs</b>					
HWD [kg]	0.00E+00	-1.46E-04	-2.86E-03	-6.97E-04	-4.51E-03
NHWD [kg]	0.00E+00	-1.94E-01	-4.02E+00	-3.36E+01	-2.76E+00
RWD [kg]	0.00E+00	-2.44E-04	-4.23E-03	-6.08E-03	-2.68E-03
CRU [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MER [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EET [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

**Table 15: Module D, 1 m<sup>3</sup> of dressed, kiln-dried hardwood.**

Parameter [Unit]	Landfill (typical)	Landfill (NGA)	Energy recovery	Reuse	Recycling
<b>Environmental Impact</b>					
GWPIB [kg CO <sub>2</sub> -eq.]	0.00E+00	-7.34E+01	-1.50E+03	-6.10E+02	-3.57E+01
GWPEB [kg CO <sub>2</sub> -eq.]	0.00E+00	-7.35E+01	-1.50E+03	-6.10E+02	-3.60E+01
ODP [kg CFC11-eq.]	0.00E+00	-5.67E-11	-9.50E-10	-1.21E-09	-4.37E-10
AP [kg SO <sub>2</sub> -eq.]	0.00E+00	-3.22E-01	-5.72E+00	-3.58E+00	-6.43E-01
EP [kg PO <sub>4</sub> <sup>3-</sup> -eq.]	0.00E+00	-2.70E-02	-5.48E-01	-7.78E-01	-1.23E-01
POCP [kg C <sub>2</sub> H <sub>4</sub> -eq.]	0.00E+00	-1.74E-02	-3.26E-01	-3.05E+00	-1.23E-01
ADPE [kg Sb-eq.]	0.00E+00	-1.93E-06	-4.93E-05	-5.14E-05	-2.67E-06
ADPF [MJ]	0.00E+00	-8.28E+02	-1.85E+04	-5.24E+03	-3.76E+02
<b>Resource Use</b>					
PERE [MJ]	0.00E+00	-5.43E+01	-8.97E+02	-3.10E+03	-2.48E+03
PERM [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT [MJ]	0.00E+00	-5.43E+01	-8.97E+02	-3.10E+03	-2.48E+03
PENRE [MJ]	0.00E+00	-8.29E+02	-1.85E+04	-5.26E+03	-3.83E+02
PENRM [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT [MJ]	0.00E+00	-8.29E+02	-1.85E+04	-5.26E+03	-3.83E+02
SM [kg]	0.00E+00	0.00E+00	0.00E+00	7.84E+02	7.84E+02
RSF [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FWB [m <sup>3</sup> ]	0.00E+00	-4.09E-01	-6.75E+00	-2.10E+00	-5.72E-01
FWG [m <sup>3</sup> ]	0.00E+00	-4.35E-02	-7.32E-01	-1.90E+03	-3.40E+01
FWT [m <sup>3</sup> ]	0.00E+00	-4.53E-01	-7.48E+00	-1.90E+03	-3.46E+01
<b>Wastes and Outputs</b>					
HWD [kg]	0.00E+00	-1.46E-04	-2.86E-03	-9.90E-04	-4.51E-03
NHWD [kg]	0.00E+00	-1.94E-01	-4.02E+00	-4.35E+01	-2.76E+00
RWD [kg]	0.00E+00	-2.44E-04	-4.23E-03	-8.00E-03	-2.68E-03
CRU [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MER [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EET [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00



**Table 16: Module D, 1 m<sup>3</sup> of rough-sawn, green hardwood.**

Parameter [Unit]	Landfill (typical)	Landfill (NGA)	Energy recovery	Reuse	Recycling
<b>Environmental Impact</b>					
GWPIB [kg CO <sub>2</sub> -eq.]	0.00E+00	-6.55E+01	-1.19E+03	-3.80E+02	-2.38E+01
GWPEB [kg CO <sub>2</sub> -eq.]	0.00E+00	-6.55E+01	-1.19E+03	-3.80E+02	-2.40E+01
ODP [kg CFC11-eq.]	0.00E+00	-5.06E-11	-7.58E-10	-4.39E-10	-2.66E-10
AP [kg SO <sub>2</sub> -eq.]	0.00E+00	-2.87E-01	-4.56E+00	-2.30E+00	-4.01E-01
EP [kg PO <sub>4</sub> <sup>3-</sup> -eq.]	0.00E+00	-2.40E-02	-4.37E-01	-5.25E-01	-7.70E-02
POCP [kg C <sub>2</sub> H <sub>4</sub> -eq.]	0.00E+00	-1.55E-02	-2.60E-01	-2.06E+00	-8.68E-02
ADPE [kg Sb-eq.]	0.00E+00	-1.72E-06	-3.93E-05	-2.37E-05	-1.75E-06
ADPF [MJ]	0.00E+00	-7.39E+02	-1.47E+04	-3.13E+03	-2.45E+02
<b>Resource Use</b>					
PERE [MJ]	0.00E+00	-4.85E+01	-7.15E+02	-1.49E+02	-1.50E+03
PERM [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT [MJ]	0.00E+00	-4.85E+01	-7.15E+02	-1.49E+02	-1.50E+03
PENRE [MJ]	0.00E+00	-7.39E+02	-1.47E+04	-3.14E+03	-2.50E+02
PENRM [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT [MJ]	0.00E+00	-7.39E+02	-1.47E+04	-3.14E+03	-2.50E+02
SM [kg]	0.00E+00	0.00E+00	0.00E+00	8.28E+02	8.28E+02
RSF [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FWB [m <sup>3</sup> ]	0.00E+00	-3.65E-01	-5.38E+00	-1.21E+00	-3.52E-01
FWG [m <sup>3</sup> ]	0.00E+00	-3.88E-02	-5.83E-01	-1.33E+03	-2.86E+01
FWT [m <sup>3</sup> ]	0.00E+00	-4.04E-01	-5.97E+00	-1.34E+03	-2.89E+01
<b>Wastes and Outputs</b>					
HWD [kg]	0.00E+00	-1.30E-04	-2.28E-03	-5.92E-04	-2.72E-03
NHWD [kg]	0.00E+00	-1.73E-01	-3.21E+00	-2.20E+01	-1.80E+00
RWD [kg]	0.00E+00	-2.17E-04	-3.37E-03	-4.32E-03	-1.64E-03
CRU [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MER [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EET [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

**Table 17: Module D, 1 m<sup>3</sup> of dressed, green hardwood.**

Parameter [Unit]	Landfill (typical)	Landfill (NGA)	Energy recovery	Reuse	Recycling
<b>Environmental Impact</b>					
GWPIB [kg CO <sub>2</sub> -eq.]	0.00E+00	-6.55E+01	-1.19E+03	-5.35E+02	-2.38E+01
GWPEB [kg CO <sub>2</sub> -eq.]	0.00E+00	-6.55E+01	-1.19E+03	-5.35E+02	-2.40E+01
ODP [kg CFC11-eq.]	0.00E+00	-5.06E-11	-7.58E-10	-9.84E-10	-2.66E-10
AP [kg SO <sub>2</sub> -eq.]	0.00E+00	-2.87E-01	-4.56E+00	-3.17E+00	-4.01E-01
EP [kg PO <sub>4</sub> <sup>3-</sup> -eq.]	0.00E+00	-2.40E-02	-4.37E-01	-6.96E-01	-7.70E-02
POCP [kg C <sub>2</sub> H <sub>4</sub> -eq.]	0.00E+00	-1.55E-02	-2.60E-01	-2.67E+00	-8.68E-02
ADPE [kg Sb-eq.]	0.00E+00	-1.72E-06	-3.93E-05	-3.17E-05	-1.75E-06
ADPF [MJ]	0.00E+00	-7.39E+02	-1.47E+04	-4.54E+03	-2.45E+02
<b>Resource Use</b>					
PERE [MJ]	0.00E+00	-4.85E+01	-7.15E+02	-2.25E+02	-1.50E+03
PERM [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT [MJ]	0.00E+00	-4.85E+01	-7.15E+02	-2.25E+02	-1.50E+03
PENRE [MJ]	0.00E+00	-7.39E+02	-1.47E+04	-4.56E+03	-2.50E+02
PENRM [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT [MJ]	0.00E+00	-7.39E+02	-1.47E+04	-4.56E+03	-2.50E+02
SM [kg]	0.00E+00	0.00E+00	0.00E+00	8.28E+02	8.28E+02
RSF [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FWB [m <sup>3</sup> ]	0.00E+00	-3.65E-01	-5.38E+00	-1.80E+00	-3.52E-01
FWG [m <sup>3</sup> ]	0.00E+00	-3.88E-02	-5.83E-01	-1.72E+03	-2.86E+01
FWT [m <sup>3</sup> ]	0.00E+00	-4.04E-01	-5.97E+00	-1.73E+03	-2.89E+01
<b>Wastes and Outputs</b>					
HWD [kg]	0.00E+00	-1.30E-04	-2.28E-03	-8.53E-04	-2.72E-03
NHWD [kg]	0.00E+00	-1.73E-01	-3.21E+00	-2.86E+01	-1.80E+00
RWD [kg]	0.00E+00	-2.17E-04	-3.37E-03	-5.72E-03	-1.64E-03
CRU [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MER [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EET [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

## Timber & Forest Certification

Many Australian timber and reconstituted wood products are certified to a forest certification scheme. This certification is an independent auditing process that provides:

- Assurance that the timber is from well-managed forests certified to internationally and nationally accepted forest management standards
- Assurance that the timber is from legally harvested sources
- Chain of custody (CoC) certification extending from the forest to the end user, which is traceable throughout the supply chain.

Two schemes apply to Australian wood production forests. One is administered by the Australian Forestry Standard Ltd (AFS). The AFS scheme is also endorsed by the international Programme for Endorsement of Forest Certification (PEFC). The other scheme is administered by the Forest Stewardship Council (FSC®) Australia.

If a Green Star project elects to use the timber credit as part of their Green Star submission, the Green Building Council of Australia recognises PEFC-endorsed forest certification schemes (such as the Australian Forest Certification Scheme, AFCS) as well as FSC®. Compliance with the CoC certification rules of either forest certification scheme for at least 95% by value of timber products used in the project will meet the requirements for this credit point (GBCA 2014).

As of 2015, there are approximately 10.6 million hectares of native and plantation forests certified in Australia, consisting of 10.1 million hectares certified under AFS and 900,000 hectares certified under FSC® (Australian Government 2015); 400,000 hectares are certified under both schemes.

In addition, many Australian hardwood manufacturers' premises listed in this EPD are CoC certified so they can supply products with CoC certification.

## Land Use and Biodiversity

Like other land uses, forestry operations for timber and wood production can have both positive and negative effects on biodiversity. However, as biodiversity varies considerably by region and as data are often limited, assessing potential biodiversity impacts within LCA is challenging.

A recent Australian study (Turner *et al.* 2014) demonstrated a new method – BioImpact – to discern the biodiversity impacts of different land uses. A trial of this method was conducted using case studies in three different regions and four production systems in New South Wales: native hardwood forestry, plantation softwood forestry, mixed cropping and rangeland grazing. The results showed that the biodiversity impacts of native hardwood production in the region studied were significantly lower than the land uses in the other regions. The management of planted softwood forests resulted in similar biodiversity impacts to those of the cropping/grazing systems.

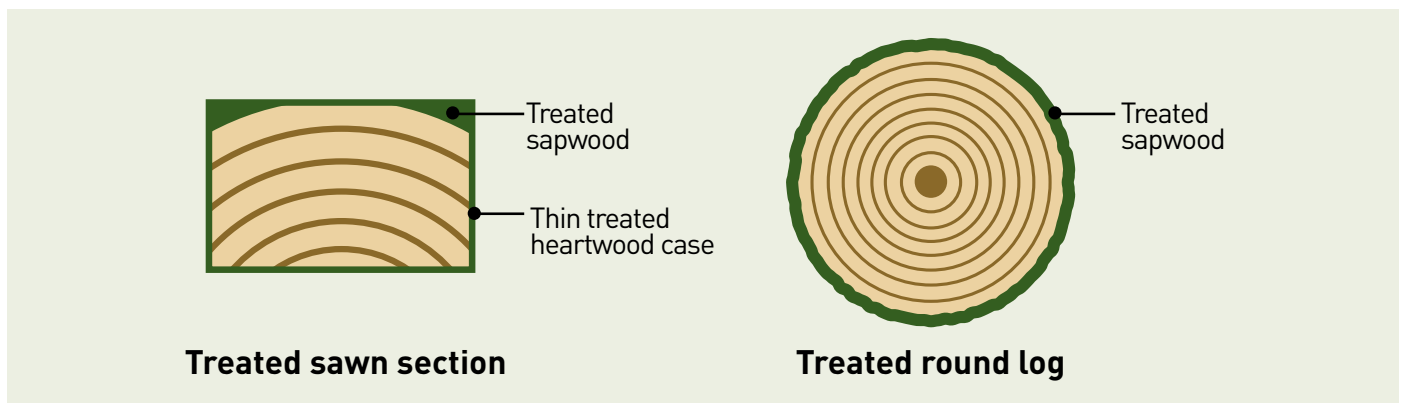
## Durability and Preservative Treatment

As described in the Scope section, this EPD covers untreated sawn hardwood products. Many of these products are naturally durable according to Australian Standard AS 5604 and will deliver a very long service life in most applications (see WoodSolutions 2012).

For use in outdoor/external exposed applications, the sapwood of some sawn hardwood species may be treated with a wood preservative for protection against borer, termite attack and/or fungal decay. It is estimated that about 38,000 m<sup>3</sup> of Australian hardwood is treated with preservative for use in exterior applications. This corresponds to approximately 5% of the 744,000 m<sup>3</sup> of Australian hardwood produced in 2012-13 (ABARES 2014).

LCA practitioners who wish to supplement data from this EPD with additional data on timber preservatives should note that:

1. Only the sapwood (located on the outer part of the tree) is actually treated with preservative. This comprises about 10% of the wood of species that are treated. It is not possible to effectively treat heartwood (the wood on the inner part of a tree) as these cells contain resins and other extractives which prevent the uptake of preservative solutions. See Figure 1 below for typical preservative penetration patterns.



**Figure 1: Preservative penetration patterns in wood.**

2. A variety of wood preservatives are approved for use. AS1604.1 sets the preservatives, the minimum preservative penetration requirements and minimum preservative retention requirements for the various Hazard Levels (H3, H4, H5 and H6, depending on the application). For more information see WoodSolutions (2015).

3. There was very little LCI data on wood preservatives used in Australia available at the time of this study. A 2010 report by EcoBalance (McCallum 2010) provides data on greenhouse gas emissions for three common timber preservation chemicals used in New Zealand: Chromated Copper Arsenate (CCA), Boron, and Light Organic Solvent Process (LOSP). These preservatives are also used to treat Australian hardwoods. Another common preservative used in Australia is Alkaline Copper Quaternary (ACQ); however, the EcoBalance study does not include data for ACQ.



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# Appendix 1 - FWPA Hardwood Producer Members

Australian Sustainable Hardwoods Pty Ltd  
Auswest Timbers Pty Ltd  
Bluebat  
Boral Timber  
Britton Bros Pty Ltd  
Dale & Meyers Operations Pty Ltd trading as DTM Timber  
Endeavour Foundation trading as Nangarin Timber  
Fenning Investments Pty Ltd trading as Fenning Bairnsdale  
Hallmark Oaks Pty Ltd  
Hexan Holdings Pty Ltd trading as Whiteland Milling  
Hurford Sawmilling Pty Ltd  
Intech Operations Pty Ltd trading as Muckerts Sawmill  
Ironwood Taree Pty Ltd  
J Notaras & Sons Pty Ltd  
Jarrahwood Australia Pty Ltd  
Kempsey Timbers trading as Australian Solar Timbers  
Machin's Sawmill Pty Ltd  
McKay Timber  
Nannup Timber Processing (NTP)  
Parkside Bldg Sup (Builyan)  
Porta Mouldings Pty Ltd  
Radial Timber Australia  
Ravenshoe Timbers Pty Ltd  
Ryan & McNulty Pty Ltd  
Timber Corporation Pty Ltd trading as Harper Timber  
Urgenty Pty Ltd trading as Mary Valley Timbers