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## Environmental Product Declaration **Particleboard**



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

EPD Registration No. S-P-00562 | Version 1.2

Issued 21 October 2015 | Revised 8 December 2017 | Valid until 8 December 2022

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**

**#06 Glued Laminated Timber (Glulam)**

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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.

This work is supported by funding provided to FWPA by the Commonwealth Government.

978-1-925213-16-4

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### Version history

**V1.0** - Initial version based on 2005/06 data from CSIRO and produced by thinkstep Pty Ltd and the Timber Development Association (NSW) Ltd.

**V1.1** - Revised version incorporating 2015/16 data from a new industry survey, as well as updates to Global Warming Potential (GWP) and fresh water indicators.

**V1.2** - Revised version for correction of the validity period, documentation of the forestry carbon modelling assumptions and correction of minor typographical errors.

Produced: December 2020

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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 that is based on a consistent set of rules known as a PCR (Product Category Rules).

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

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## CEN standard EN 15804 served as the core PCR

### PCR:

PCR 2012:01 Construction products and Construction services, Version 2.2, 2017-05-30

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The Technical Committee of the International EPD® System.

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☐ EPD process certification (Internal)

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### Verifier approved by: EPD Australasia Ltd

# Introduction

This Environmental Product Declaration presents the average performance of particleboard manufactured in Australia from Australian grown wood residues 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 particleboard.

This EPD has been prepared in accordance with ISO 14025:2006, EN 15804:2013 and PCR 2012:01 (IEPDS 2017). It covers standard and moisture resistant particleboard panels that have a decorative overlay and flooring products produced in accordance with the following standards:

- AS/NZS 1859.1:2004 Reconstituted wood-based panels – Specifications – Particleboard
- AS/NZS 1859.3:2005 Reconstituted wood-based panels – Specifications – Decorative and overlaid wood panels
- AS/NZS 1860.1:2002 Particleboard flooring – Specifications.

The environmental data presented in this document are primarily derived from a survey of industry members covering the 2015/16 financial year conducted by thinkstep and Stephen Mitchell Associates on behalf of FWPA. This updates an earlier survey conducted by CSIRO (2009) based on the 2005/06 financial year, which was used in the first version of this EPD. The current survey covers 54% of total particleboard production in Australia.

Production of this EPD has been facilitated by FWPA with participation of its current particleboard producer members (listed below) and the Engineered Wood Products Association of Australasia (EWPA):

- Carter Holt Harvey Woodproducts Australia
- D&R Hendersen Pty Ltd
- The Laminex Group

All companies above have contributed financially to this project through levies paid to FWPA. The companies that contributed data cannot be identified due to the small number of Australian producers, as it would then be possible to back-calculate the data of individual FWPA members.

## Description of the Australian Particleboard Industry

The Australian particleboard industry is an important contributor to the Australian economy – particularly to the regional economies where mills are based. The overall contribution of the wood products industries to the Australian GDP in 2015-16 was 0.5% [ABARES 2017b]. In 2015-16, Australian particleboard manufacturers produced 955,000 cubic metres of particleboard products (ABARES 2017b) in seven different facilities.

## Description of Particleboard Products

Particleboard production uses wood residues as its main input. These include pulp logs, forest thinnings, log harvesting residues, co-products of sawmilling and post-consumer wood.

Particleboard is a composite panel that can be engineered for specific applications. It is widely used to manufacture kitchens, wardrobes, laundries, furniture, wall panels, architectural joinery and flooring in retail fit outs, multi-residential buildings, hotels and housing projects.

## Use of EPDs in Sustainable Building and Infrastructure Rating Systems

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 Table 1).

It may be used by project teams using the *Design & As Built* and *Interiors* rating tools to obtain Green Star points under the following credits:

- Materials > Product Transparency and Sustainability.
- Materials > Life Cycle Assessment: By providing data for an EN 15978 compliant whole-of-building whole-of-life assessment.
- Innovation Challenge > Responsible Carbon Impact: By providing embodied carbon impacts (i.e. data on Global Warming Potential) which can be used in the calculation and reduction of the total embodied carbon impacts of a project.

This EPD is also recognised for credits in the Infrastructure Sustainability (IS) rating scheme of the Infrastructure Sustainability Council of Australia (ISCA).

## Products

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

- 1m<sup>2</sup> of particleboard, 16 mm E0 & E1 standard melamine coated
- 1m<sup>2</sup> of particleboard, 18 mm E0 & E1 standard melamine coated
- 1m<sup>2</sup> of particleboard, 16 mm E0 & E1 moisture resistant (MR) melamine coated
- 1m<sup>2</sup> of particleboard, 18 mm E0 & E1 moisture resistant (MR) melamine coated
- 1m<sup>2</sup> of particleboard, 19 mm flooring (tongue & groove)
- 1m<sup>2</sup> of particleboard, 22 mm flooring (tongue & groove)
- 1m<sup>2</sup> of particleboard, 25 mm flooring (tongue & groove)

All wood used in these products is from Australian native and exotic (non-native) softwood species grown in plantations. The dominant softwood species used to produce particleboard in Australia is *Pinus radiata* (radiata pine). Other softwood species used are *Araucaria cunninghami* (hoop pine), *Pinus pinaster* (maritime pine) and the Southern Pines: *Pinus elliottii* (slash pine), *Pinus caribaea* (Caribbean pine) and hybrids thereof.

The properties and material composition of these particleboard products are defined in Table 1 and Table 2 below.

**Table 1: Properties of particleboard products included in this EPD.**

Properties	Std 16 mm	Std 18 mm	MR 16 mm	MR 18 mm	Flooring 19 mm	Flooring 22 mm	Flooring 25 mm
Area density (kg per m <sup>2</sup> )	10.6	11.8	10.6	11.8	13.6	15.9	18.3
Density (kg per m <sup>3</sup> )	660	656	660	656	718	723	731
Moisture content (dry basis)	8%	7%	8%	7%	10%	9%	9%
Gross calorific value (MJ/kg)	20.5	20.5	20.7	20.6	20.6	20.7	20.7
Net calorific value (MJ/kg)	17.5	17.7	17.7	17.9	17.3	17.4	17.4
CO <sub>2</sub> sequestered (kg CO <sub>2</sub> e)	16.5	18.4	16.4	18.3	19.6	23.1	26.5

**Table 2: Composition of particleboard products included in this EPD.**

Materials	Std 16 mm	Std 18 mm	MR 16 mm	MR 18 mm	Flooring 19 mm	Flooring 22 mm	Flooring 25 mm
Softwood (dry)	84.1%	84.2%	83.5%	83.4%	77.6%	78.6%	78.6%
Urea formaldehyde	5.9%	7.3%	0.4%	0.2%	0.0%	0.0%	0.0%
Melamine formaldehyde (lamination)	0.8%	0.6%	0.8%	0.6%	0.0%	0.0%	0.0%
Melamine urea formaldehyde	0.0%	0.0%	6.0%	7.6%	10.9%	10.6%	10.7%
Paraffin wax	0.5%	0.4%	0.7%	0.6%	0.8%	0.9%	0.9%
Lamination paper (dry)	1.3%	1.1%	1.3%	1.1%	0.0%	0.0%	0.0%
Tongue (polypropylene)	0.0%	0.0%	0.0%	0.0%	0.5%	0.5%	0.5%
Ammonium sulphate	0.1%	0.2%	0.2%	0.2%	0.3%	0.0%	0.3%
Tannin	0.0%	0.0%	0.0%	0.0%	0.9%	0.8%	0.7%
Preservative	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Dyes	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Water	7.3%	6.2%	7.2%	6.3%	8.9%	8.6%	8.4%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

The declared units above represent an entire product category rather than a specific product from a specific manufacturer. The values represent an average weighted by production volume. 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.

Representativeness

**Market coverage:** The data in this EPD are from detailed surveys of three of the seven particleboard plants in Australia. These three plants collectively produced 514,000 m3 of particleboard in 2015/16, equating to 54% of total Australian production of approximately 955,000 m3 (based on the 2015/16 total from ABARES 2017a). Coverage of total production by FWPA members is also 54% as all Australian particleboard producers are members.

**Temporal representativeness:** Primary data were collected from participating sites for the 2015/16 Australian financial year (1st July 2015 to 30th June 2016). Following EN 15804, site-specific data are valid for 5 years (to 30th June 2021), meaning that these datasets are valid until the end of this EPD’s validity period.

**Geographical and technological representativeness:** The data are representative of particleboard produced in Australia as the sites surveyed collectively produce more than half of all Australian-produced particleboard. The averages presented in this EPD are weighted by production volumes. More detailed information can be found in the “Variation in Results” section later in this EPD.

Industry Classifications

Product	Classification	Code	Category
All	UN CPC Ver.2	31430	Particle board and similar board of wood or other ligneous materials
All	ANZSIC 2006	1494	Reconstituted Wood Product Manufacturing



# 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.

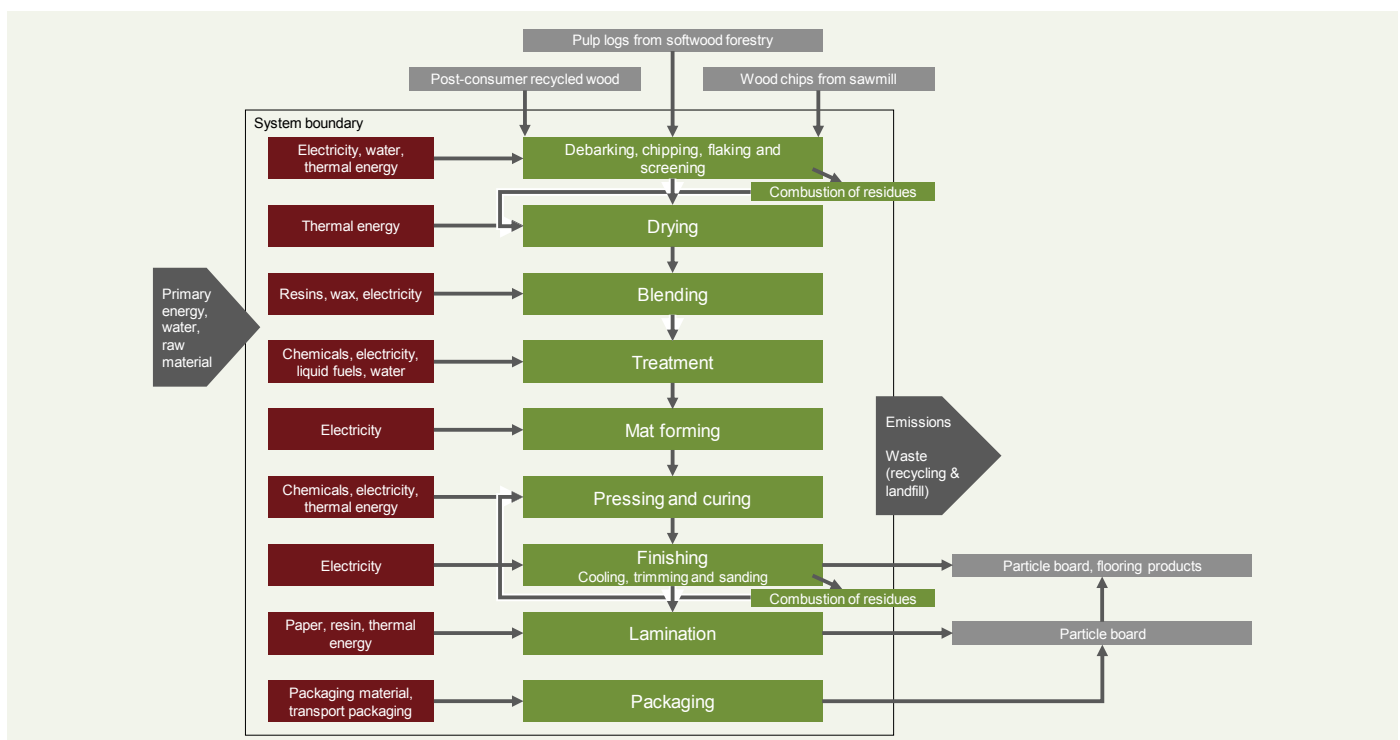
Product stage			Con- struction process stage		Use stage							End-of-life stage				Benefits and loads beyond the system boundary
Raw material supply	Transport of raw materials	Manufacturing	Transport to customer	Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational 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	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	X	X	X

Key: X = included in the EPD

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

## Production

The production stage includes growth and harvesting of wood inputs, production of resin and wax, blending of wood particles with resin and wax, pressing of the mixture to create the particleboard substrate, cutting, sanding and – if applied – adding a melamine-impregnated paper layer to the top and bottom surfaces.





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. With the exception of reuse, which is not common for particleboard, 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 (DOC<sub>f</sub>) 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 estimates of the DOC<sub>f</sub> value that would apply over very long time horizons (Australian Government 2014a, p.17).

- **Landfill (typical):** DOC<sub>f</sub> = 1.6%. This is based on bioreactor laboratory research by Ximenes *et al.* (2013).
- **Landfill (NGA):** DOC<sub>f</sub> = 10%. This is the value chosen for Australia's National Greenhouse Accounts (NGA) (Australian Government 2017). This is a reduction from the previous value of 23% (Australian Government 2014b) that 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 DOC<sub>f</sub> value can be considered extremely conservative when compared to values from later research (as used in the typical scenario above) and effectively assumes that at least part of the wood waste is ground into a powder to accelerate degradation.

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 2016, Table 43).
- 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). The year 2020 was chosen as landfill will take place in the future and this was the last year for which forecasts were available.
- Of this 36% captured, 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 2016, Table 43) 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 (module C3) and combustion with recovered energy offset against average thermal energy from natural gas (module D) in line with EN 16485:2014 (Section 6.3.4.5). Note that other options are also in use within Australia, including replacement of coal, replacement of electricity, and replacement of both electricity and thermal energy (via co-generation). The modelling assumes that the product waste has value after it has been sorted.

## Recycling

Particleboard may be recycled in many different ways – including into new particleboard. This scenario considers shredding into wood chips. Wood waste is chipped (module C3) and assigned credits relative to the avoided production of woodchips from virgin softwood (module D). 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:** Thermal energy and transport fuels have been modelled as the Australian average (see thinkstep 2017 for documentation). Electricity for production (modules A1-A3) has been modelled as a state-specific split based upon the electricity consumption of the manufacturers who contributed data to this study. Electricity at end-of-life (module C) has been modelled using an average Australian electricity mix as the location where the product reaches end-of-life is unknown.

**Forestry:** All breakdown of forest matter after harvest is modelled as aerobic and therefore carbon neutral as carbon sequestered is released as carbon dioxide. Any burning of forestry material left behind after logging is modelled as being carbon neutral, aside from the trace emissions of various organic gases (Commonwealth of Australia, 2016). All forestry is assumed to be sustainably managed and as such there are no carbon emissions associated with land use change. Loss of carbon from the soil is assumed to be zero (i.e. no significant erosion). It is assumed that all timber will be replanted (plantation forest) or will regrow (native forest) after bushfires.

## 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 2017, Section 7.5.4). 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 2017).

**Co-products (i.e. different particleboard products):** Wood particles and energy are allocated per cubic metre of board produced. Decorative overlays are allocated by square metre applied. The polypropylene tongue in flooring is allocated based on square metres of board. Resins and waxes are allocated based on the dry mass required in average recipes supplied by manufacturers.

**Post-consumer waste:** Post-consumer particleboard waste is used by some sites to manufacture new particleboard. In these cases, the end of waste state is deemed to occur at deposit of this waste at a waste treatment facility, meaning that the incoming particleboard waste is considered burden-free. Only the impact of transport from the waste treatment facility to the production plant is included within module A1-A3.

## Background Data

Data for primary wood inputs (pulplog and wood chips from sawmills) use the same forestry and sawmilling data as FWPA EPD #01 for Softwood Timber, but with different economic allocation factors.

Data for all energy inputs, transport processes and raw materials are from GaBi Databases 2017 (thinkstep 2017). Most datasets have a reference year between 2013 and 2015 and all fall within the 10-year limit allowable for generic data under EN 15804 (Section 6.3.7).

# 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.

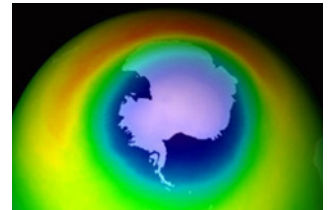
### Global Warming Potential (GWP) → Climate Change

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 as a total as well as being separated into biogenic carbon (GWPB) and fossil carbon (GWPF).



### 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 (ADP) → 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 3: Environmental impacts, 1 m<sup>2</sup> of particleboard, 16 mm E0 & E1 standard melamine coated.**

	Production	Landfill (typical)	Landfill (NGA)	Energy recovery	Recycling
Parameter [Unit]	A1-A3	C4	C4	C3	C3
GWP [kg CO <sub>2</sub> -eq.]	-10.2	1.86	6.74	17.7	17.7
GWPF [kg CO <sub>2</sub> -eq.]	6.23	0.942	0.999	1.14	1.14
GWPB [kg CO <sub>2</sub> -eq.]	-16.4	0.918	5.74	16.5	16.5
ODP [kg CFC11-eq.]	2.01E-11	4.48E-13	4.48E-13	4.62E-15	4.62E-15
AP [kg SO <sub>2</sub> -eq.]	0.0262	0.00300	0.00332	6.74E-04	6.74E-04
EP [kg PO <sub>4</sub> <sup>3-</sup> -eq.]	0.00502	0.00156	0.00772	1.58E-04	1.58E-04
POCP [kg C <sub>2</sub> H <sub>4</sub> -eq.]	0.00938	3.60E-04	0.00131	5.85E-05	5.85E-05
ADPE [kg Sb-eq.]	1.12E-06	1.86E-07	1.86E-07	1.34E-09	1.34E-09
ADPF [MJ]	87.8	13.5	13.5	1.40	1.40

**Table 4: Environmental impacts, 1 m<sup>2</sup> of particleboard, 18 mm E0 & E1 standard melamine coated**

	Production	Landfill (typical)	Landfill (NGA)	Energy recovery	Recycling
Parameter [Unit]	A1-A3	C4	C4	C3	C3
GWP [kg CO <sub>2</sub> -eq.]	-11.1	2.09	7.58	19.9	19.9
GWPF [kg CO <sub>2</sub> -eq.]	7.26	1.06	1.13	1.44	1.44
GWPB [kg CO <sub>2</sub> -eq.]	-18.3	1.03	6.45	18.4	18.4
ODP [kg CFC11-eq.]	2.81E-11	5.04E-13	5.04E-13	5.16E-15	5.16E-15
AP [kg SO <sub>2</sub> -eq.]	0.0299	0.00338	0.00374	7.53E-04	7.53E-04
EP [kg PO <sub>4</sub> <sup>3-</sup> -eq.]	0.00643	0.00200	0.0102	1.76E-04	1.76E-04
POCP [kg C <sub>2</sub> H <sub>4</sub> -eq.]	0.0116	4.05E-04	0.00147	6.54E-05	6.54E-05
ADPE [kg Sb-eq.]	1.48E-06	2.09E-07	2.09E-07	1.49E-09	1.49E-09
ADPF [MJ]	106	15.2	15.2	1.56	1.56

**Table 5: Environmental impacts, 1 m<sup>2</sup> of particleboard, 16 mm E0 & E1 moisture resistant (MR) melamine coated.**

	Production	Landfill (typical)	Landfill (NGA)	Energy recovery	Recycling
Parameter [Unit]	A1-A3	C4	C4	C3	C3
GWP [kg CO <sub>2</sub> -eq.]	-8.53	1.86	6.77	17.7	17.7
GWPF [kg CO <sub>2</sub> -eq.]	7.78	0.944	1.01	1.35	1.35
GWPB [kg CO <sub>2</sub> -eq.]	-16.3	0.921	5.76	16.4	16.4
ODP [kg CFC11-eq.]	3.30E-11	4.48E-13	4.48E-13	4.62E-15	4.62E-15
AP [kg SO <sub>2</sub> -eq.]	0.0268	0.00300	0.00332	6.74E-04	6.74E-04
EP [kg PO <sub>4</sub> <sup>3-</sup> -eq.]	0.00610	0.00174	0.00890	1.58E-04	1.58E-04
POCP [kg C <sub>2</sub> H <sub>4</sub> -eq.]	0.00837	3.61E-04	0.00132	5.85E-05	5.85E-05
ADPE [kg Sb-eq.]	2.56E-06	1.86E-07	1.86E-07	1.34E-09	1.34E-09
ADPF [MJ]	111	13.5	13.5	1.40	1.40

**Table 6: Environmental impacts, 1 m<sup>2</sup> of particleboard, 18 mm E0 & E1 moisture resistant (MR) melamine coated.**

	Production	Landfill (typical)	Landfill (NGA)	Energy recovery	Recycling
Parameter [Unit]	A1-A3	C4	C4	C3	C3
GWP [kg CO <sub>2</sub> -eq.]	-8.76	2.10	7.61	19.9	19.9
GWPF [kg CO <sub>2</sub> -eq.]	9.40	1.06	1.15	1.68	1.68
GWPB [kg CO <sub>2</sub> -eq.]	-18.2	1.03	6.46	18.3	18.3
ODP [kg CFC11-eq.]	4.61E-11	5.04E-13	5.04E-13	5.16E-15	5.16E-15
AP [kg SO <sub>2</sub> -eq.]	0.0302	0.00338	0.00374	7.54E-04	7.54E-04
EP [kg PO <sub>4</sub> <sup>3--</sup> -eq.]	0.00776	0.00224	0.0118	1.76E-04	1.76E-04
POCP [kg C <sub>2</sub> H <sub>4</sub> -eq.]	0.00976	4.05E-04	0.00148	6.54E-05	6.54E-05
ADPE [kg Sb-eq.]	3.55E-06	2.09E-07	2.09E-07	1.49E-09	1.49E-09
ADPF [MJ]	137	15.2	15.2	1.56	1.56

**Table 7: Environmental impacts, 1 m<sup>2</sup> of particleboard, 19 mm flooring.**

	Production	Landfill (typical)	Landfill (NGA)	Energy recovery	Recycling
Parameter [Unit]	A1-A3	C4	C4	C3	C3
GWP [kg CO <sub>2</sub> -eq.]	-7.23	2.28	8.46	22.3	22.3
GWPF [kg CO <sub>2</sub> -eq.]	12.1	1.14	1.28	2.74	2.74
GWPB [kg CO <sub>2</sub> -eq.]	-19.3	1.15	7.18	19.6	19.6
ODP [kg CFC11-eq.]	1.30E-10	5.33E-13	5.33E-13	5.97E-15	5.97E-15
AP [kg SO <sub>2</sub> -eq.]	0.0377	0.00360	0.00400	8.71E-04	8.71E-04
EP [kg PO <sub>4</sub> <sup>3--</sup> -eq.]	0.0109	0.00315	0.0172	2.04E-04	2.04E-04
POCP [kg C <sub>2</sub> H <sub>4</sub> -eq.]	0.00980	4.44E-04	0.00165	7.56E-05	7.56E-05
ADPE [kg Sb-eq.]	9.99E-06	2.21E-07	2.21E-07	1.73E-09	1.73E-09
ADPF [MJ]	182	16.1	16.1	1.80	1.80

**Table 8: Environmental impacts, 1 m<sup>2</sup> of particleboard, 22 mm flooring.**

	Production	Landfill (typical)	Landfill (NGA)	Energy recovery	Recycling
Parameter [Unit]	A1-A3	C4	C4	C3	C3
GWP [kg CO <sub>2</sub> -eq.]	-9.18	2.67	9.92	26.3	26.3
GWPF [kg CO <sub>2</sub> -eq.]	13.7	1.32	1.48	3.13	3.13
GWPB [kg CO <sub>2</sub> -eq.]	-22.9	1.35	8.45	23.1	23.1
ODP [kg CFC11-eq.]	1.36E-10	6.18E-13	6.18E-13	6.96E-15	6.96E-15
AP [kg SO <sub>2</sub> -eq.]	0.0428	0.00417	0.00465	0.00102	0.00102
EP [kg PO <sub>4</sub> <sup>3--</sup> -eq.]	0.0122	0.00352	0.0192	2.38E-04	2.38E-04
POCP [kg C <sub>2</sub> H <sub>4</sub> -eq.]	0.0115	5.19E-04	0.00193	8.82E-05	8.82E-05
ADPE [kg Sb-eq.]	1.12E-05	2.55E-07	2.55E-07	2.01E-09	2.01E-09
ADPF [MJ]	205	18.6	18.6	2.10	2.10

**Table 9: Environmental impacts, 1 m<sup>2</sup> of particleboard, 25 mm flooring.**

	Production	Landfill (typical)	Landfill (NGA)	Energy recovery	Recycling
Parameter [Unit]	A1-A3	C4	C4	C3	C3
GWP [kg CO <sub>2</sub> -eq.]	-10.5	3.05	11.4	30.1	30.1
GWPF [kg CO <sub>2</sub> -eq.]	15.7	1.50	1.68	3.61	3.61
GWPB [kg CO <sub>2</sub> -eq.]	-26.2	1.55	9.69	26.5	26.5
ODP [kg CFC11-eq.]	1.53E-10	7.02E-13	7.02E-13	7.99E-15	7.99E-15
AP [kg SO <sub>2</sub> -eq.]	0.0488	0.00475	0.00529	0.00117	0.00117
EP [kg PO <sub>4</sub> <sup>3--</sup> -eq.]	0.0139	0.00411	0.0225	2.73E-04	2.73E-04
POCP [kg C <sub>2</sub> H <sub>4</sub> -eq.]	0.0131	5.93E-04	0.00221	1.01E-04	1.01E-04
ADPE [kg Sb-eq.]	1.27E-05	2.90E-07	2.90E-07	2.31E-09	2.31E-09
ADPF [MJ]	236	21.1	21.1	2.42	2.42

## Resource Use

**Table 10: Resource use, 1 m<sup>2</sup> of particleboard, 16 mm E0 & E1 standard melamine coated.**

	Production	Landfill (typical)	Landfill (NGA)	Energy recovery	Recycling
Parameter [Unit]	A1-A3	C4	C4	C3	C3
PERE [MJ]	53.6	0.850	0.850	0.0253	0.0253
PERM [MJ]	173	0	0	-173	-173
PERT [MJ]	227	0.850	0.850	-173	-173
PENRE [MJ]	88.9	13.7	13.7	1.40	1.40
PENRM [MJ]	14.2	0	0	-14.2	-14.2
PENRT [MJ]	103	13.7	13.7	-12.8	-12.8
SM [kg]	0.543	0	0	0	0
RSF [MJ]	0	0	0	0	0
NRSF [MJ]	0	0	0	0	0
FW [m <sup>3</sup> ]	0.0371	1.92E-04	7.36E-04	1.53E-05	1.53E-05

**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;

**FW** = Net use of fresh water



**Table 11: Resource use, 1 m<sup>2</sup> of particleboard, 18 mm E0 & E1 standard melamine coated.**

	Production	Landfill (typical)	Landfill (NGA)	Energy recovery	Recycling
Parameter [Unit]	A1-A3	C4	C4	C3	C3
PERE [MJ]	49.9	0.956	0.956	0.0283	0.0283
PERM [MJ]	193	0	0	-193	-193
PERT [MJ]	243	0.956	0.956	-193	-193
PENRE [MJ]	108	15.4	15.4	1.56	1.56
PENRM [MJ]	18.2	0	0	-18.2	-18.2
PENRT [MJ]	126	15.4	15.4	-16.6	-16.6
SM [kg]	0.104	0	0	0	0
RSF [MJ]	0	0	0	0	0
NRSF [MJ]	0	0	0	0	0
FW [m <sup>3</sup> ]	0.0339	2.16E-04	8.27E-04	1.71E-05	1.71E-05

**Table 12: Resource use, 1 m<sup>2</sup> of particleboard, 16 mm E0 & E1 moisture resistant (MR) melamine coated.**

	Production	Landfill (typical)	Landfill (NGA)	Energy recovery	Recycling
Parameter [Unit]	A1-A3	C4	C4	C3	C3
PERE [MJ]	54.0	0.850	0.850	0.0253	0.0253
PERM [MJ]	172	0	0	-172	-172
PERT [MJ]	226	0.850	0.850	-172	-172
PENRE [MJ]	113	13.7	13.7	1.40	1.40
PENRM [MJ]	17.0	0	0	-17.0	-17.0
PENRT [MJ]	130	13.7	13.7	-15.6	-15.6
SM [kg]	0.447	0	0	0	0
RSF [MJ]	0	0	0	0	0
NRSF [MJ]	0	0	0	0	0
FW [m <sup>3</sup> ]	0.0502	1.93E-04	7.39E-04	1.53E-05	1.53E-05

**Table 13: Resource use, 1 m<sup>2</sup> of particleboard, 18 mm E0 & E1 moisture resistant (MR) melamine coated.**

	Production	Landfill (typical)	Landfill (NGA)	Energy recovery	Recycling
Parameter [Unit]	A1-A3	C4	C4	C3	C3
PERE [MJ]	52.3	0.956	0.956	0.0283	0.0283
PERM [MJ]	191	0	0	-191	-191
PERT [MJ]	244	0.956	0.956	-191	-191
PENRE [MJ]	139	15.4	15.4	1.56	1.56
PENRM [MJ]	21.4	0	0	-21.4	-21.4
PENRT [MJ]	161	15.4	15.4	-19.9	-19.9
SM [kg]	0.131	0	0	0	0
RSF [MJ]	0	0	0	0	0
NRSF [MJ]	0	0	0	0	0
FW [m <sup>3</sup> ]	0.0551	2.17E-04	8.30E-04	1.71E-05	1.71E-05

**Table 14: Resource use, 1 m<sup>2</sup> of particleboard, 19 mm flooring.**

	Production	Landfill (typical)	Landfill (NGA)	Energy recovery	Recycling
Parameter [Unit]	A1-A3	C4	C4	C3	C3
PERE [MJ]	62.1	1.01	1.01	0.0327	0.0327
PERM [MJ]	203	0	0	-203	-203
PERT [MJ]	265	1.01	1.01	-203	-203
PENRE [MJ]	188	16.4	16.4	1.80	1.80
PENRM [MJ]	35.3	0	0	-35.3	-35.3
PENRT [MJ]	223	16.4	16.4	-33.5	-33.5
SM [kg]	0	0	0	0	0
RSF [MJ]	0	0	0	0	0
NRSF [MJ]	0	0	0	0	0
FW [m <sup>3</sup> ]	0.281	2.41E-04	9.28E-04	1.98E-05	1.98E-05

**Table 15: Resource use, 1 m<sup>2</sup> of particleboard, 22 mm flooring.**

	Production	Landfill (typical)	Landfill (NGA)	Energy recovery	Recycling
Parameter [Unit]	A1-A3	C4	C4	C3	C3
PERE [MJ]	69.1	1.17	1.17	0.0382	0.0382
PERM [MJ]	240	0	0	-240	-240
PERT [MJ]	309	1.17	1.17	-240	-240
PENRE [MJ]	210	18.9	18.9	2.11	2.11
PENRM [MJ]	40.2	0	0	-40.2	-40.2
PENRT [MJ]	250	18.9	18.9	-38.1	-38.1
SM [kg]	0	0	0	0	0
RSF [MJ]	0	0	0	0	0
NRSF [MJ]	0	0	0	0	0
FW [m <sup>3</sup> ]	0.286	2.82E-04	0.00109	2.31E-05	2.31E-05

**Table 16: Resource use, 1 m<sup>2</sup> of particleboard, 25 mm flooring.**

	Production	Landfill (typical)	Landfill (NGA)	Energy recovery	Recycling
Parameter [Unit]	A1-A3	C4	C4	C3	C3
PERE [MJ]	78.1	1.33	1.33	0.0438	0.0438
PERM [MJ]	276	0	0	-276	-276
PERT [MJ]	354	1.33	1.33	-276	-276
PENRE [MJ]	241	21.5	21.5	2.42	2.42
PENRM [MJ]	46.5	0	0	-46.5	-46.5
PENRT [MJ]	288	21.5	21.5	-44.0	-44.0
SM [kg]	0	0	0	0	0
RSF [MJ]	0	0	0	0	0
NRSF [MJ]	0	0	0	0	0
FW [m <sup>3</sup> ]	0.316	3.23E-04	0.00125	2.65E-05	2.65E-05

**Table 17: Waste categories, 1 m<sup>2</sup> of particleboard, 16 mm E0 & E1 standard melamine coated.**

	Production	Landfill (typical)	Landfill (NGA)	Energy recovery	Recycling
Parameter [Unit]	A1-A3	C4	C4	C3	C3
HWD [kg]	8.82E-08	4.74E-08	4.74E-08	2.32E-09	2.32E-09
NHWD [kg]	0.174	10.3	8.86	9.62E-06	9.62E-06
RWD [kg]	4.42E-04	9.73E-05	9.73E-05	8.39E-08	8.39E-08
CRU [kg]	0	0	0	0	0
MFR [kg]	0	0	0	0	10.6
MER [kg]	0	0	0	10.6	0
EEE [MJ]	0	0.248	1.55	0	0
EET [MJ]	0	0	0	0	0

*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 18: Waste categories, 1 m<sup>2</sup> of particleboard, 18 mm E0 & E1 standard melamine coated.**

	Production	Landfill (typical)	Landfill (NGA)	Energy recovery	Recycling
Parameter [Unit]	A1-A3	C4	C4	C3	C3
HWD [kg]	9.45E-08	5.31E-08	5.31E-08	2.59E-09	2.59E-09
NHWD [kg]	0.224	11.5	9.89	1.08E-05	1.08E-05
RWD [kg]	5.96E-04	1.09E-04	1.09E-04	9.38E-08	9.38E-08
CRU [kg]	0	0	0	0	0
MFR [kg]	0	0	0	0	11.8
MER [kg]	0	0	0	11.8	0
EEE [MJ]	0	0.279	1.75	0	0
EET [MJ]	0	0	0	0	0

**Table 19: Waste categories, 1 m<sup>2</sup> of particleboard, 16mm E0 & E1 moisture resistant (MR) melamine coated.**

	Production	Landfill (typical)	Landfill (NGA)	Energy recovery	Recycling
Parameter [Unit]	A1-A3	C4	C4	C3	C3
HWD [kg]	8.88E-08	4.74E-08	4.74E-08	2.32E-09	2.32E-09
NHWD [kg]	0.224	10.3	8.85	9.62E-06	9.62E-06
RWD [kg]	7.04E-04	9.73E-05	9.73E-05	8.39E-08	8.39E-08
CRU [kg]	0	0	0	0	0
MFR [kg]	0	0	0	0	10.6
MER [kg]	0	0	0	10.6	0
EEE [MJ]	0	0.250	1.56	0	0
EET [MJ]	0	0	0	0	0

**Table 20: Waste categories, 1 m<sup>2</sup> of particleboard, 18 mm E0 & E1 moisture resistant (MR) melamine coated.**

	Production	Landfill (typical)	Landfill (NGA)	Energy recovery	Recycling
Parameter [Unit]	A1-A3	C4	C4	C3	C3
HWD [kg]	9.41E-08	5.32E-08	5.32E-08	2.59E-09	2.59E-09
NHWD [kg]	0.286	11.5	9.88	1.08E-05	1.08E-05
RWD [kg]	9.62E-04	1.09E-04	1.09E-04	9.38E-08	9.38E-08
CRU [kg]	0	0	0	0	0
MFR [kg]	0	0	0	0	11.8
MER [kg]	0	0	0	11.8	0
EEE [MJ]	0	0.280	1.75	0	0
EET [MJ]	0	0	0	0	0

**Table 21: Waste categories, 1 m<sup>2</sup> of particleboard, 19 mm flooring.**

	Production	Landfill (typical)	Landfill (NGA)	Energy recovery	Recycling
Parameter [Unit]	A1-A3	C4	C4	C3	C3
HWD [kg]	5.37E-08	5.88E-08	5.88E-08	2.99E-09	2.99E-09
NHWD [kg]	0.312	13.3	11.5	1.24E-05	1.24E-05
RWD [kg]	0.00167	1.16E-04	1.16E-04	1.08E-07	1.08E-07
CRU [kg]	0	0	0	0	0
MFR [kg]	0	0	0	0	13.6
MER [kg]	0	0	0	13.6	0
EEE [MJ]	0	0.314	1.96	0	0
EET [MJ]	0	0	0	0	0

**Table 22: Waste categories, 1 m<sup>2</sup> of particleboard, 22 mm flooring.**

	Production	Landfill (typical)	Landfill (NGA)	Energy recovery	Recycling
Parameter [Unit]	A1-A3	C4	C4	C3	C3
HWD [kg]	5.77E-08	6.84E-08	6.84E-08	3.49E-09	3.49E-09
NHWD [kg]	0.363	15.6	13.4	1.45E-05	1.45E-05
RWD [kg]	0.00183	1.34E-04	1.34E-04	1.26E-07	1.26E-07
CRU [kg]	0	0	0	0	0
MFR [kg]	0	0	0	0	15.9
MER [kg]	0	0	0	15.9	0
EEE [MJ]	0	0.369	2.31	0	0
EET [MJ]	0	0	0	0	0

**Table 23: Waste categories, 1 m<sup>2</sup> of particleboard, 25 mm flooring.**

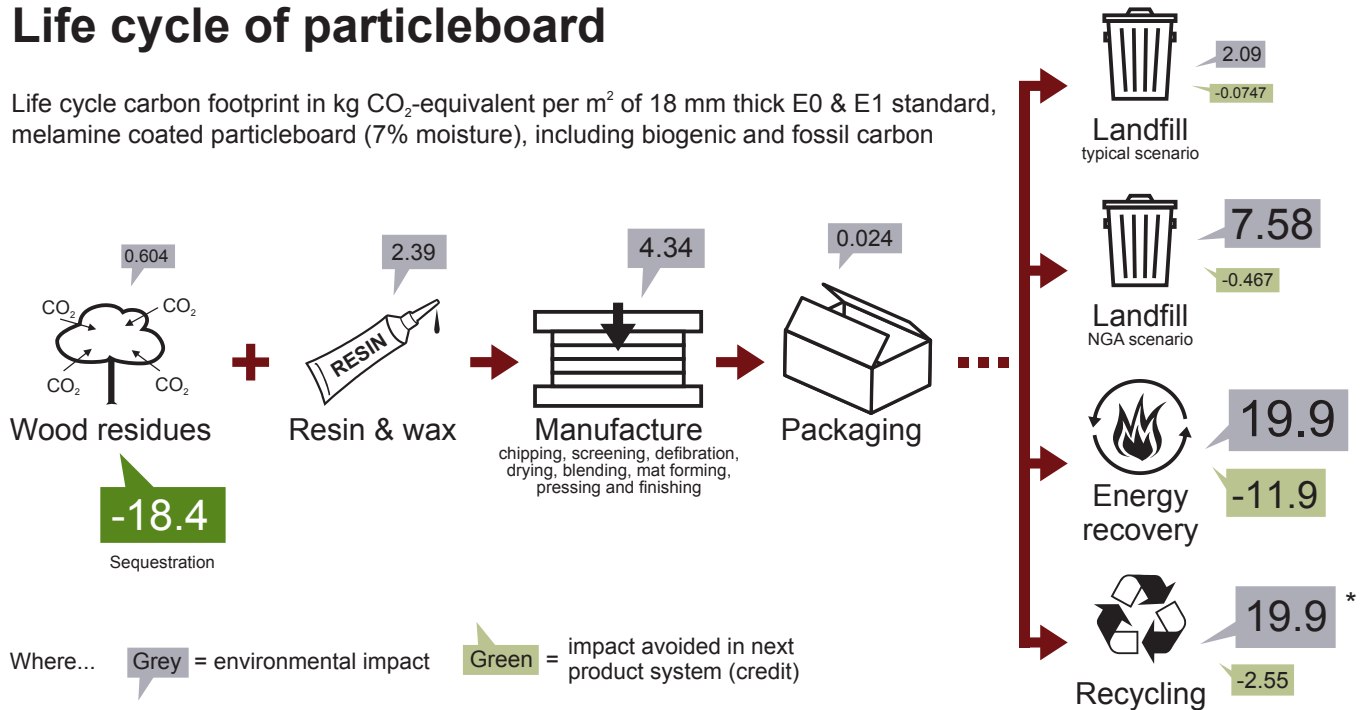
	Production	Landfill (typical)	Landfill (NGA)	Energy recovery	Recycling
Parameter [Unit]	A1-A3	C4	C4	C3	C3
HWD [kg]	6.51E-08	7.82E-08	7.82E-08	4.01E-09	4.01E-09
NHWD [kg]	0.417	17.9	15.3	1.66E-05	1.66E-05
RWD [kg]	0.00208	1.52E-04	1.52E-04	1.45E-07	1.45E-07
CRU [kg]	0	0	0	0	0
MFR [kg]	0	0	0	0	18.3
MER [kg]	0	0	0	18.3	0
EEE [MJ]	0	0.424	2.65	0	0
EET [MJ]	0	0	0	0	0

# Interpretation

## Understanding the Life Cycle of Particleboard

### Life cycle of particleboard

Life cycle carbon footprint in kg CO<sub>2</sub>-equivalent per m<sup>2</sup> of 18 mm thick E0 & E1 standard, melamine coated particleboard (7% moisture), including biogenic and fossil carbon



\* While carbon is not released directly through recycling, it is passed to another product system and is therefore counted as being released

## Variation in Results

The variation between sites used to create the average shown in this EPD are given in Table 24 below for the environmental impact indicators in modules A1-A3.

**Table 24: Inter-site variability for standard particleboard (modules A1-A3).**

	Standard 16 mm			Standard 18 mm		
Parameter [Unit]	Min	Max	CV	Min	Max	CV
GWP [kg CO <sub>2</sub> -eq.]	-6.5%	+2.4%	±2.0%	-4.1%	+1.4%	±1.4%
GWPF [kg CO <sub>2</sub> -eq.]	-10.7%	+3.2%	±3.8%	-5.9%	+4.4%	±0.8%
GWPB [kg CO <sub>2</sub> -eq.]	-0.3%	+0.0%	±0.2%	-0.1%	+0.9%	±0.5%
ODP [kg CFC11-eq.]	-4.9%	+22.0%	±13.5%	-4.5%	+0.6%	±2.5%
AP [kg SO <sub>2</sub> -eq.]	-24.2%	+7.2%	±8.5%	-17.5%	+7.7%	±4.9%
EP [kg PO <sub>4</sub> <sup>3</sup> -eq.]	-8.3%	+9.8%	±9.1%	-8.8%	+2.3%	±3.2%
POCP [kg C <sub>2</sub> H <sub>4</sub> -eq.]	-3.4%	+8.0%	±5.7%	-6.1%	+1.1%	±2.5%
ADPE [kg Sb-eq.]	-17.6%	+18.5%	±0.5%	-0.7%	+12.7%	±6.0%
ADPF [MJ]	-7.3%	+5.5%	±6.4%	-2.0%	+1.1%	±0.5%

**Min** = (minimum - average) / average; **Max** = (maximum - average) / average;

**CV** = coefficient of variation = standard deviation / average



**Table 25: Inter-site variability for moisture resistant particleboard (modules A1-A3).**

	Moisture resistant 16 mm			Moisture resistant 18 mm		
Parameter [Unit]	Min	Max	CV	Min	Max	CV
GWP [kg CO <sub>2</sub> -eq.]	-12.5%	+8.0%	±10.2%	-12.4%	+3.4%	±4.5%
GWPF [kg CO <sub>2</sub> -eq.]	-12.9%	+7.1%	±10.0%	-12.6%	+2.9%	±4.8%
GWPB [kg CO <sub>2</sub> -eq.]	-0.4%	+0.8%	±0.6%	-0.1%	+0.5%	±0.3%
ODP [kg CFC11-eq.]	-13.3%	+32.9%	±23.1%	-15.8%	+3.6%	±9.7%
AP [kg SO <sub>2</sub> -eq.]	-24.7%	+5.2%	±9.7%	-21.3%	+7.2%	±7.0%
EP [kg PO <sub>4</sub> <sup>3</sup> -eq.]	-12.0%	+15.7%	±13.8%	-14.7%	+0.0%	±7.4%
POCP [kg C <sub>2</sub> H <sub>4</sub> -eq.]	-3.7%	+3.1%	±3.4%	-4.5%	+1.5%	±1.5%
ADPE [kg Sb-eq.]	-2.9%	+32.2%	±17.6%	-11.3%	+4.3%	±7.8%
ADPF [MJ]	-10.9%	+14.8%	±12.9%	-11.0%	+1.1%	±6.1%

**Table 26: Inter-site variability for particleboard flooring (modules A1-A3).**

	Flooring 19 mm			Flooring 22 mm			Flooring 25 mm		
Parameter [Unit]	Min	Max	CV	Min	Max	CV	Min	Max	CV
GWP [kg CO <sub>2</sub> -eq.]	-20.4%	+8.9%	±5.8%	-20.8%	+4.5%	±8.1%	-10.6%	+7.1%	±1.7%
GWPF [kg CO <sub>2</sub> -eq.]	-9.6%	+5.7%	±2.0%	-13.3%	+3.5%	±4.9%	-9.6%	+4.2%	±2.7%
GWPB [kg CO <sub>2</sub> -eq.]	-1.7%	+0.2%	±0.9%	-0.4%	+0.3%	±0.3%	-0.4%	+1.5%	±0.9%
ODP [kg CFC11-eq.]	-53.5%	+5.2%	±29.4%	-53.6%	+15.9%	±34.8%	-49.1%	+17.3%	±33.2%
AP [kg SO <sub>2</sub> -eq.]	-19.1%	+13.6%	±2.7%	-17.4%	+15.6%	±0.9%	-17.6%	+13.2%	±2.2%
EP [kg PO <sub>4</sub> <sup>3</sup> -eq.]	-14.0%	+1.9%	±6.1%	-16.8%	+1.3%	±9.1%	-12.9%	+0.8%	±6.8%
POCP [kg C <sub>2</sub> H <sub>4</sub> -eq.]	-6.7%	+82.6%	±37.9%	-3.9%	+80.9%	±38.5%	-4.5%	+79.8%	±37.7%
ADPE [kg Sb-eq.]	-12.5%	+4.2%	±8.3%	-15.7%	+7.7%	±11.7%	-14.0%	+8.0%	±11.0%
ADPF [MJ]	-6.2%	+2.9%	±1.7%	-10.3%	+0.6%	±4.8%	-6.4%	+1.4%	±2.5%

## 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 (Gifford 2000).

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).

# Other Environmental Information

## Module D: Recycling, Reuse and Recovery Potentials

**Table 27: Module D, 1 m<sup>2</sup> of particleboard, 16 mm E0 & E1 standard melamine coated.**

Parameter [Unit]	Landfill (typical)	Landfill (NGA)	Energy recovery	Recycling
<b>Environmental Impact</b>				
GWP [kg CO <sub>2</sub> -eq.]	-0.0664	-0.415	-10.7	-2.27
GWPF [kg CO <sub>2</sub> -eq.]	-0.0664	-0.415	-10.7	-2.17
GWPB [kg CO <sub>2</sub> -eq.]	-1.36E-06	-8.48E-06	0.0265	-0.1000
ODP [kg CFC11-eq.]	-1.90E-15	-1.19E-14	2.08E-13	-1.89E-13
AP [kg SO <sub>2</sub> -eq.]	-2.93E-04	-0.00183	0.00362	-0.0167
EP [kg PO <sub>4</sub> <sup>3--</sup> -eq.]	-2.47E-05	-1.54E-04	5.97E-04	-0.00386
POCP [kg C <sub>2</sub> H <sub>4</sub> -eq.]	-1.53E-05	-9.54E-05	0.00208	-0.00686
ADPE [kg Sb-eq.]	-4.94E-09	-3.09E-08	-6.91E-07	-4.12E-07
ADPF [MJ]	-0.757	-4.73	-205	-27.7
<b>Resource Use</b>				
PERE [MJ]	-0.0850	-0.532	0.0696	-40.1
PERM [MJ]	0	0	0	0
PERT [MJ]	-0.0850	-0.532	0.0696	-40.1
PENRE [MJ]	-0.757	-4.73	-205	-27.8
PENRM [MJ]	0	0	0	0
PENRT [MJ]	-0.757	-4.73	-205	-27.8
SM [kg]	0	0	0	10.6
RSF [MJ]	0	0	173	0
NRSF [MJ]	0	0	14.2	0
FW [m <sup>3</sup> ]	-3.93E-04	-0.00245	0.00310	-0.00853
<b>Wastes and Outputs</b>				
HWD [kg]	-9.99E-11	-6.24E-10	-1.55E-08	-8.14E-09
NHWD [kg]	-1.93E-04	-0.00121	0.487	-0.285
RWD [kg]	-9.33E-08	-5.83E-07	2.61E-05	-1.00E-05
CRU [kg]	0	0	0	0
MFR [kg]	0	0	0	0
MER [kg]	0	0	0	0
EEE [MJ]	0	0	0	0
EET [MJ]	0	0	0	0

**Table 28: Module D, 1 m<sup>2</sup> of particleboard, 18 mm E0 & E1 standard melamine coated.**

Parameter [Unit]	Landfill (typical)	Landfill (NGA)	Energy recovery	Recycling
<b>Environmental Impact</b>				
GWP [kg CO <sub>2</sub> -eq.]	-0.0747	-0.467	-11.9	-2.55
GWPF [kg CO <sub>2</sub> -eq.]	-0.0747	-0.467	-11.9	-2.44
GWPB [kg CO <sub>2</sub> -eq.]	-1.53E-06	-9.54E-06	0.0296	-0.113
ODP [kg CFC11-eq.]	-2.13E-15	-1.33E-14	3.08E-13	-2.12E-13
AP [kg SO <sub>2</sub> -eq.]	-3.29E-04	-0.00206	0.00531	-0.0188
EP [kg PO <sub>4</sub> <sup>3--</sup> -eq.]	-2.78E-05	-1.74E-04	0.00101	-0.00434
POCP [kg C <sub>2</sub> H <sub>4</sub> -eq.]	-1.72E-05	-1.07E-04	0.00239	-0.00771
ADPE [kg Sb-eq.]	-5.55E-09	-3.47E-08	-7.74E-07	-4.63E-07
ADPF [MJ]	-0.852	-5.32	-231	-31.2
<b>Resource Use</b>				
PERE [MJ]	-0.0957	-0.598	0.105	-45.1
PERM [MJ]	0	0	0	0
PERT [MJ]	-0.0957	-0.598	0.105	-45.1
PENRE [MJ]	-0.852	-5.32	-231	-31.2
PENRM [MJ]	0	0	0	0
PENRT [MJ]	-0.852	-5.32	-231	-31.2
SM [kg]	0	0	0	11.8
RSF [MJ]	0	0	193	0
NRSF [MJ]	0	0	18.2	0
FW [m <sup>3</sup> ]	-4.42E-04	-0.00276	0.00415	-0.00959
<b>Wastes and Outputs</b>				
HWD [kg]	-1.12E-10	-7.02E-10	-1.74E-08	-9.16E-09
NHWD [kg]	-2.17E-04	-0.00136	0.543	-0.321
RWD [kg]	-1.05E-07	-6.56E-07	3.69E-05	-1.13E-05
CRU [kg]	0	0	0	0
MFR [kg]	0	0	0	0
MER [kg]	0	0	0	0
EEE [MJ]	0	0	0	0
EET [MJ]	0	0	0	0

**Table 29: Module D, 1 m<sup>2</sup> of particleboard, 16 mm E0 & E1 moisture resistant (MR) melamine coated.**

Parameter [Unit]	Landfill (typical)	Landfill (NGA)	Energy recovery	Recycling
<b>Environmental Impact</b>				
GWP [kg CO <sub>2</sub> -eq.]	-0.0667	-0.417	-10.6	-2.27
GWPF [kg CO <sub>2</sub> -eq.]	-0.0667	-0.417	-10.7	-2.17
GWPB [kg CO <sub>2</sub> -eq.]	-1.36E-06	-8.52E-06	0.0264	-0.1000
ODP [kg CFC11-eq.]	-1.91E-15	-1.19E-14	2.38E-13	-1.89E-13
AP [kg SO <sub>2</sub> -eq.]	-2.94E-04	-0.00184	0.00442	-0.0167
EP [kg PO <sub>4</sub> <sup>3--</sup> -eq.]	-2.48E-05	-1.55E-04	8.13E-04	-0.00386
POCP [kg C <sub>2</sub> H <sub>4</sub> -eq.]	-1.53E-05	-9.59E-05	0.00211	-0.00686
ADPE [kg Sb-eq.]	-4.96E-09	-3.10E-08	-6.94E-07	-4.12E-07
ADPF [MJ]	-0.761	-4.76	-207	-27.7
<b>Resource Use</b>				
PERE [MJ]	-0.0855	-0.534	0.0847	-40.1
PERM [MJ]	0	0	0	0
PERT [MJ]	-0.0855	-0.534	0.0847	-40.1
PENRE [MJ]	-0.761	-4.76	-207	-27.8
PENRM [MJ]	0	0	0	0
PENRT [MJ]	-0.761	-4.76	-207	-27.8
SM [kg]	0	0	0	10.6
RSF [MJ]	0	0	172	0
NRSF [MJ]	0	0	17.0	0
FW [m <sup>3</sup> ]	-3.95E-04	-0.00247	0.00343	-0.00853
<b>Wastes and Outputs</b>				
HWD [kg]	-1.00E-10	-6.27E-10	-1.55E-08	-8.14E-09
NHWD [kg]	-1.94E-04	-0.00121	0.484	-0.285
RWD [kg]	-9.38E-08	-5.86E-07	3.00E-05	-1.00E-05
CRU [kg]	0	0	0	0
MFR [kg]	0	0	0	0
MER [kg]	0	0	0	0
EEE [MJ]	0	0	0	0
EET [MJ]	0	0	0	0

**Table 30: Module D, 1 m<sup>2</sup> of particleboard, 18 mm E0 & E1 moisture resistant (MR) melamine coated.**

Parameter [Unit]	Landfill (typical)	Landfill (NGA)	Energy recovery	Recycling
<b>Environmental Impact</b>				
GWP [kg CO <sub>2</sub> -eq.]	-0.0750	-0.469	-11.8	-2.55
GWPF [kg CO <sub>2</sub> -eq.]	-0.0750	-0.469	-11.8	-2.44
GWPB [kg CO <sub>2</sub> -eq.]	-1.53E-06	-9.58E-06	0.0295	-0.113
ODP [kg CFC11-eq.]	-2.14E-15	-1.34E-14	3.45E-13	-2.12E-13
AP [kg SO <sub>2</sub> -eq.]	-3.31E-04	-0.00207	0.00634	-0.0188
EP [kg PO <sub>4</sub> <sup>3--</sup> -eq.]	-2.79E-05	-1.74E-04	0.00129	-0.00434
POCP [kg C <sub>2</sub> H <sub>4</sub> -eq.]	-1.72E-05	-1.08E-04	0.00242	-0.00771
ADPE [kg Sb-eq.]	-5.58E-09	-3.48E-08	-7.75E-07	-4.63E-07
ADPF [MJ]	-0.855	-5.34	-232	-31.2
<b>Resource Use</b>				
PERE [MJ]	-0.0961	-0.600	0.124	-45.1
PERM [MJ]	0	0	0	0
PERT [MJ]	-0.0961	-0.600	0.124	-45.1
PENRE [MJ]	-0.855	-5.35	-232	-31.2
PENRM [MJ]	0	0	0	0
PENRT [MJ]	-0.855	-5.35	-232	-31.2
SM [kg]	0	0	0	11.8
RSF [MJ]	0	0	191	0
NRSF [MJ]	0	0	21.4	0
FW [m <sup>3</sup> ]	-4.44E-04	-0.00277	0.00457	-0.00959
<b>Wastes and Outputs</b>				
HWD [kg]	-1.13E-10	-7.05E-10	-1.74E-08	-9.16E-09
NHWD [kg]	-2.18E-04	-0.00136	0.539	-0.321
RWD [kg]	-1.05E-07	-6.59E-07	4.18E-05	-1.13E-05
CRU [kg]	0	0	0	0
MFR [kg]	0	0	0	0
MER [kg]	0	0	0	0
EEE [MJ]	0	0	0	0
EET [MJ]	0	0	0	0

**Table 31: Module D, 1 m<sup>2</sup> of particleboard, 19 mm flooring.**

Parameter [Unit]	Landfill (typical)	Landfill (NGA)	Energy recovery	Recycling
<b>Environmental Impact</b>				
GWP [kg CO <sub>2</sub> -eq.]	-0.0840	-0.525	-12.7	-2.69
GWPF [kg CO <sub>2</sub> -eq.]	-0.0840	-0.525	-12.7	-2.57
GWPB [kg CO <sub>2</sub> -eq.]	-1.72E-06	-1.07E-05	0.0323	-0.119
ODP [kg CFC11-eq.]	-2.40E-15	-1.50E-14	5.92E-13	-2.24E-13
AP [kg SO <sub>2</sub> -eq.]	-3.70E-04	-0.00231	0.0111	-0.0198
EP [kg PO <sub>4</sub> <sup>3--</sup> -eq.]	-3.13E-05	-1.95E-04	0.00252	-0.00458
POCP [kg C <sub>2</sub> H <sub>4</sub> -eq.]	-1.93E-05	-1.21E-04	0.00285	-0.00814
ADPE [kg Sb-eq.]	-6.24E-09	-3.90E-08	-8.51E-07	-4.89E-07
ADPF [MJ]	-0.958	-5.98	-259	-32.9
<b>Resource Use</b>				
PERE [MJ]	-0.108	-0.672	0.219	-47.6
PERM [MJ]	0	0	0	0
PERT [MJ]	-0.108	-0.672	0.219	-47.6
PENRE [MJ]	-0.958	-5.99	-259	-33.0
PENRM [MJ]	0	0	0	0
PENRT [MJ]	-0.958	-5.99	-259	-33.0
SM [kg]	0	0	0	13.6
RSF [MJ]	0	0	203	0
NRSF [MJ]	0	0	35.3	0
FW [m <sup>3</sup> ]	-4.97E-04	-0.00310	0.00690	-0.0101
<b>Wastes and Outputs</b>				
HWD [kg]	-1.26E-10	-7.90E-10	-1.93E-08	-9.67E-09
NHWD [kg]	-2.44E-04	-0.00153	0.583	-0.339
RWD [kg]	-1.18E-07	-7.38E-07	6.92E-05	-1.19E-05
CRU [kg]	0	0	0	0
MFR [kg]	0	0	0	0
MER [kg]	0	0	0	0
EEE [MJ]	0	0	0	0
EET [MJ]	0	0	0	0

**Table 32: Module D, 1 m<sup>2</sup> of particleboard, 22 mm flooring.**

Parameter [Unit]	Landfill (typical)	Landfill (NGA)	Energy recovery	Recycling
<b>Environmental Impact</b>				
GWP [kg CO <sub>2</sub> -eq.]	-0.0988	-0.617	-15.1	-3.12
GWPF [kg CO <sub>2</sub> -eq.]	-0.0988	-0.617	-15.1	-2.98
GWPB [kg CO <sub>2</sub> -eq.]	-2.02E-06	-1.26E-05	0.0380	-0.138
ODP [kg CFC11-eq.]	-2.82E-15	-1.76E-14	6.58E-13	-2.59E-13
AP [kg SO <sub>2</sub> -eq.]	-4.35E-04	-0.00272	0.0123	-0.0229
EP [kg PO <sub>4</sub> <sup>3--</sup> -eq.]	-3.68E-05	-2.30E-04	0.00277	-0.00530
POCP [kg C <sub>2</sub> H <sub>4</sub> -eq.]	-2.27E-05	-1.42E-04	0.00331	-0.00943
ADPE [kg Sb-eq.]	-7.34E-09	-4.59E-08	-1.00E-06	-5.66E-07
ADPF [MJ]	-1.13	-7.04	-305	-38.1
<b>Resource Use</b>				
PERE [MJ]	-0.126	-0.790	0.244	-55.1
PERM [MJ]	0	0	0	0
PERT [MJ]	-0.126	-0.790	0.244	-55.1
PENRE [MJ]	-1.13	-7.04	-305	-38.2
PENRM [MJ]	0	0	0	0
PENRT [MJ]	-1.13	-7.04	-305	-38.2
SM [kg]	0	0	0	15.9
RSF [MJ]	0	0	240	0
NRSF [MJ]	0	0	40.2	0
FW [m <sup>3</sup> ]	-5.84E-04	-0.00365	0.00775	-0.0117
<b>Wastes and Outputs</b>				
HWD [kg]	-1.49E-10	-9.28E-10	-2.27E-08	-1.12E-08
NHWD [kg]	-2.87E-04	-0.00180	0.686	-0.392
RWD [kg]	-1.39E-07	-8.67E-07	7.74E-05	-1.38E-05
CRU [kg]	0	0	0	0
MFR [kg]	0	0	0	0
MER [kg]	0	0	0	0
EEE [MJ]	0	0	0	0
EET [MJ]	0	0	0	0



**Table 33: Module D, 1 m<sup>2</sup> of particleboard, 25 mm flooring.**

Parameter [Unit]	Landfill (typical)	Landfill (NGA)	Energy recovery	Recycling
<b>Environmental Impact</b>				
GWP [kg CO <sub>2</sub> -eq.]	-0.113	-0.708	-17.3	-3.54
GWPF [kg CO <sub>2</sub> -eq.]	-0.113	-0.708	-17.3	-3.38
GWPB [kg CO <sub>2</sub> -eq.]	-2.31E-06	-1.45E-05	0.0436	-0.156
ODP [kg CFC11-eq.]	-3.24E-15	-2.02E-14	7.67E-13	-2.95E-13
AP [kg SO <sub>2</sub> -eq.]	-4.99E-04	-0.00312	0.0144	-0.0261
EP [kg PO <sub>4</sub> <sup>3--</sup> -eq.]	-4.22E-05	-2.64E-04	0.00325	-0.00603
POCP [kg C <sub>2</sub> H <sub>4</sub> -eq.]	-2.60E-05	-1.63E-04	0.00381	-0.0107
ADPE [kg Sb-eq.]	-8.42E-09	-5.26E-08	-1.15E-06	-6.44E-07
ADPF [MJ]	-1.29	-8.07	-350	-43.3
<b>Resource Use</b>				
PERE [MJ]	-0.145	-0.907	0.284	-62.6
PERM [MJ]	0	0	0	0
PERT [MJ]	-0.145	-0.907	0.284	-62.6
PENRE [MJ]	-1.29	-8.08	-350	-43.4
PENRM [MJ]	0	0	0	0
PENRT [MJ]	-1.29	-8.08	-350	-43.4
SM [kg]	0	0	0	18.3
RSF [MJ]	0	0	276	0
NRSF [MJ]	0	0	46.5	0
FW [m <sup>3</sup> ]	-6.70E-04	-0.00419	0.00900	-0.0133
<b>Wastes and Outputs</b>				
HWD [kg]	-1.70E-10	-1.07E-09	-2.60E-08	-1.27E-08
NHWD [kg]	-3.30E-04	-0.00206	0.789	-0.445
RWD [kg]	-1.59E-07	-9.95E-07	9.01E-05	-1.57E-05
CRU [kg]	0	0	0	0
MFR [kg]	0	0	0	0
MER [kg]	0	0	0	0
EEE [MJ]	0	0	0	0
EET [MJ]	0	0	0	0

## Water Consumption

The “FW” indicator in the EPD results tables reports consumption (i.e. net use) of ‘blue water’ (which includes river water, lake water and ground water). This indicator deliberately excludes consumption of ‘green’ water (rain water).

PCR 2012:01 (Section 16.1) states that all water loss from a drainage basin is considered consumption, including any net loss of rain water. According to the PCR, net loss should be interpreted as any additional water loss beyond what would occur in the original, natural system. For plantation softwood forestry, the natural system might be a native forest or a grassland (Quinteiro et al. 2015).

The initial version of this EPD (v1.0) included estimated losses of rain water in the main results tables, labelled as green water consumption. These values were based on calculated differences in water flow between plantation forests and a base case land use (pasture) from the original CSIRO LCI study (CSIRO 2009).

Table 34 reports green water consumption calculated by CSIRO using 2005-08 data. These values have not been updated and are now reported here rather than in the main results tables to reflect their uncertainty. At the time of writing, there is no internationally agreed method for calculating green water consumption due to evapotranspiration relative to a hypothetical natural state (Manzardo et al. 2016). As such, different calculation methods may yield significantly different results, introducing a high level of uncertainty.

The reader should also be aware that water consumption does not account for relative water stress in the catchment(s) where the forest is located, meaning that it provides no information about the potential impacts of any water consumption that does occur.

**Table 34: Green water consumption estimates for modules A1-A3 from CSIRO (2009).**

	Std 16 mm	Std 18 mm	MR 16 mm	MR 18 mm	Floor 19 mm	Floor 222 mm	Floor 25 mm
Parameter [Unit]	A1-A3	A1-A3	A1-A3	A1-A3	A1-A3	A1-A3	A1-A3
Green water consumption in forest [m <sup>3</sup> ]	1.30	1.82	1.39	1.79	1.14	1.47	1.71

## 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

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 chain of custody 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 2017, there are more than 26.7 million hectares of native and plantation forests certified under AFS (AFS 2017) and 1.2 million hectares certified under FSC® interim national standards (FSC 2017).

All Australian particleboard manufacturers are chain of custody certified and can therefore supply certified products.

## 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.

An Australian study completed shortly before initial publication of this EPD (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. Managed forestry resulted in biodiversity impacts equivalent to or better than those of cropping/grazing systems.

## Indoor Environment Quality – Formaldehyde Emissions Minimisation

Formaldehyde is a colourless, strong-smelling gas that occurs naturally in the environment. It is present in the air that we breathe at natural background levels of about 0.03 parts per million (ppm) with recent studies showing formaldehyde concentrations often up to 0.08 ppm in outdoor urban air (EWPAA 2012). Formaldehyde is used as an ingredient in synthetic resins, industrial chemicals and preservatives, and in the production of paper, textiles, cosmetics, disinfectants, medicines, paints, varnishes and lubricants.

Particleboard manufactured in Australia uses one of two modern low formaldehyde emitting amino plastics: urea formaldehyde (UF) or melamine urea formaldehyde (MUF).

To assure end users that their particleboard has the lowest possible formaldehyde emissions, a formaldehyde testing and labelling program is run by the Engineered Wood Products Association of Australasia. Participating mills are required to forward samples to EWPAA's National Laboratory on a regular basis for formaldehyde emission testing. On the basis of laboratory tests and audits of the manufacturing process, participating Australian particleboard mills are permitted to brand a formaldehyde emission class on their particleboard products as detailed in Table 31 below.

**Table 31: Formaldehyde emission classes for Australian manufactured particleboard**

Emission Class	Emission Limit (mg/litre)	Emission Limit (ppm)*
E0	Less than or equal to 0.5	Less than or equal to 0.04
E1	Less than or equal to 1.0	Less than or equal to 0.08

\* Based on a test chamber volume of 10litre, zero airflow during the 24hr test cycle, molecular weight of formaldehyde 30.03 and the number of microlitres of formaldehyde gas in 1 micromole at 101KPa and 298K.

All Australian manufacturers listed in this EPD can supply test certificates that support their emissions class. Please contact your manufacturer individually for further definite information.

Particleboard with formaldehyde emissions of less than or equal to E1 are compliant with the Green Star Formaldehyde credit. To achieve credit points all engineered wood products such as particleboard, MDF and plywood used in the construction project must be in accordance with these requirements.

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