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Environmental Product Declaration
Softwood Timber

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

EPD Registration No. S-P-00560 | Version 1.1
Revised 13 July 2015 | Valid until 22 June 2020

Geographical Scope: Australia

AUSTRALASIA EPD®
ENVIRONMENTAL PRODUCT DECLARATION

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 an industry initiative designed to provide independent, non-proprietary information about timber and wood products to professionals and companies involved in building design and construction.

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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Produced: June 2015, revised July 2015

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.

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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.
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Independent verification of the declaration and data, according to ISO 14025:
☐ EPD process certification (Internal)
☑ EPD verification (External)

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Introduction

This Environmental Product Declaration presents the average performance of sawn timber from Australian grown softwood 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 softwood.

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

- AS/NZS 1748 Timber – Mechanically stress-graded for structural purposes
- AS 2858 Timber – Softwood – Visually stress-graded for structural purposes
- AS 4785 Timber – Softwood – 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 50% of total softwood log production in Australia and 40-50% of total softwood sawmilling in Australia. Production of the EPD and validation of the data have been facilitated by FWPA with participation of its current sawn softwood timber producer members listed in Appendix 1.

Description of the Australian Sawn Softwood Industry

The Australian sawn softwood 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 products industries to the Australian GDP in 2010-11 was 0.59% (or $8.3 billion added value) (ABARES 2013). In 2012-13 Australian softwood industry produced 3.8 million cubic metres of sawn timber products (ABARES 2014) across 61 different facilities (Gavran *et al.* 2014).

The distribution of softwood mills by state is included in Table 1. Production is dominated by large sawmills, 20 of which have an input capacity greater than 100,000 m^3 of softwood sawlogs per year.

Table 1: Softwood sawmills by Australian state

NSW[a]	Vic.	Qld	SA	WA[b]	Tas.	Aust.
14	11	16	14	3	3	61

a Includes ACT
b includes Northern Territory. Source: Gavran et al. 2014

Description of Sawn Softwood Products

Seasoned sawn softwood is widely used in residential and multi-residential frame construction (wall frames: studs, plates, headers; floor and roof truss components) and other internal fit-out elements (see Table 2).

Structural grade seasoned softwood is usually sold with a dressed surface finish (planer gauged). It may also be rougher headed, which is a reeded finish. Structural softwood is also available preservative treated (see Other Environmental Information section) for a variety of internal (termite protected) and external (termite and decay protected) applications; however, this EPD covers untreated softwood only. Factory manufactured finger-jointed and metal plate connector joined products are also available.

Appearance grade seasoned softwood is usually sold for internal fit-out elements such as mouldings, wall and ceiling linings, furniture, cladding and flooring.

Table 2: Proportion of Australian softwood by product group (2014).
Source: FWPA Softwood Timber Survey 2015.

Softwood product	% of total
Outdoor domestic	8%
Fencing	4%
Appearance	1%
Structural untreated	34%
LOSP	1%
Structural H2F	20%
Landscaping	6%
Poles	1%
Packaging	16%
Ungraded / non-structural	9%
Total	**100%**

Image courtesy of Timberlink Australia

Image courtesy of Timberlink Australia

Seasoned sawn softwood timber is sold by grades for strength or appearance and the quantity specified by cross section and lineal metres. Although it is possible to cut timber to a large range of cross sections, there are a number of common dimensions for the dominant building products such as timber studs for floor, wall and roof framing (see Table 3 and Table 4).

Table 3: Structural grades of seasoned sawn softwood and availability. Source: WPV 2009

Typical species	Stress grade	Supply
Radiata Pine, Hoop Pine, Slash Pine, Maritime Pine, Caribbean Pine	F5	Readily available
	F7	Available from selected suppliers
	MGP10	Readily available
	MGP12	Available from selected suppliers
	MGP15	Available from selected suppliers

Table 4: Structural seasoned softwood - available sizes. Source: WPV 2009.

Breadth (mm)	Depth (mm)							
	42	70	90	120	140	190	240	290
35	X	Y	Y	Y	Y	Y	X	X
45		Y	Y	Y	Y	Y	Y	Y
90			X					

Key: X = Available from selected suppliers; Y = Readily available

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 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.

Scope

Products

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

- *1 m^3 of sawn kiln-dried softwood*
  12% moisture content (dry basis), density of 550 kg/m^3
- *1 m^3 of dressed kiln-dried softwood*
  12% moisture content (dry basis), density of 550 kg/m^3

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 sawn timber 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.

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

Sawn kiln-dried softwood	Structural framing, utility grade (non-structural applications)
Dressed sawn kiln-dried softwood	Mouldings, architraves, joinery, furniture, flooring grades

Representativeness

Forestry data came from four case studies spanning five states (Qld, Vic, NSW, SA and WA), which together covered 50% of Australian production at the time of the original study (CSIRO 2009). Sawmilling and drying data was from eight softwood mills representing 40-50% of total sawn softwood production in Australia at the time of the original study (CSIRO 2009).

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
All	ANZSIC 2006	1413	Timber resawing and dressing

LCA Calculation Rules

System Boundary

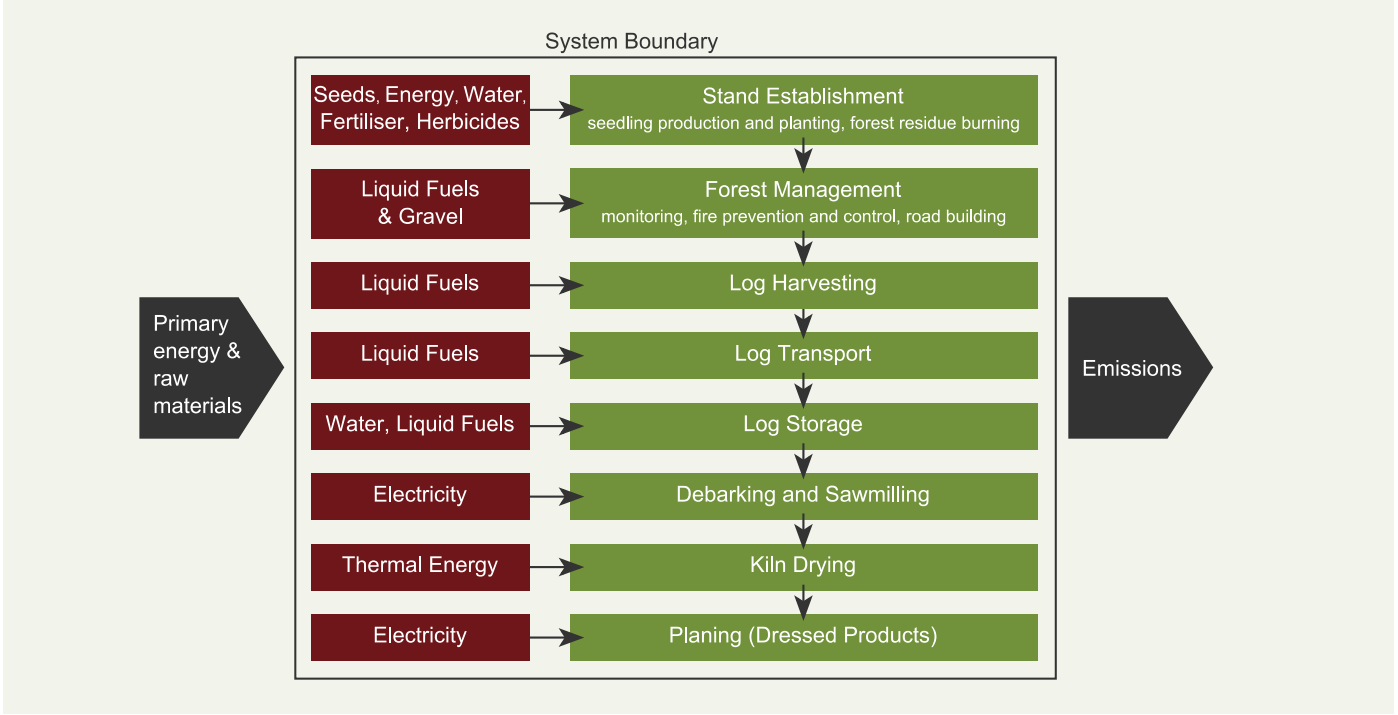
This EPD is of the 'cradle-to-gate' type with options. The options include the end-of-life stage, which is modelled through the use of scenarios.

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, sawmilling and kiln drying stages for all products and planing for dressed timber. Preservative treatment is not included within the scope of this EPD.



End-of-Life

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 softwood, 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 radiata pine timber, the dominant softwood 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).

Recycling

Softwood may be recycled in many different ways. This scenario considers shredding and effectively downcycling 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 CO_2 sequestered 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 four planing datasets for softwood timber from the Consortium for Research on Renewable Industrial Materials has been applied (CORRIM 2013a-2013d).

All Australian electricity is assumed to be the 2011 national average with a Global Warming Potential of 1,004 g CO_2e/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

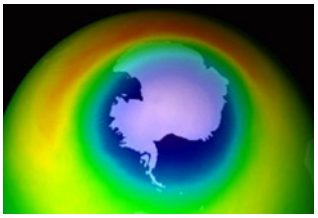
Note: these tables show the impacts associated with production and end-of-life.
Any potential credits to future products from recycling or energy recovery are presented in the Other Environmental Information section.

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^+) 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_3), 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 5: Environmental impacts, 1 m³ of sawn, kiln-dried softwood.

	Production	Landfill (typical)	Landfill (NGA)	Energy recovery	Recycling
Parameter [Unit]	**A1-A3**	**C4**	**C4**	**C3**	**C3**
GWPIB [kg CO_2-eq.]	-6.89E+02	6.12E+01	7.49E+02	9.06E+02	9.06E+02
GWPEB [kg CO_2-eq.]	2.12E+02	6.04E+01	5.45E+02	5.62E+00	5.62E+00
ODP [kg CFC11-eq.]	3.49E-09	5.26E-10	5.26E-10	1.78E-10	1.78E-10
AP [kg SO_2-eq.]	1.05E+00	1.83E-01	2.28E-01	8.91E-01	3.57E-02
EP [kg PO_4^{3-}-eq.]	3.05E-01	2.32E-02	3.45E-02	1.79E-01	8.45E-03
POCP [kg C_2H_4-eq.]	5.77E-01	1.68E-02	1.51E-01	9.54E-02	3.78E-03
ADPE [kg Sb-eq.]	3.65E-05	1.12E-05	1.13E-05	9.40E-08	9.40E-08
ADPF [MJ]	2.45E+03	8.42E+02	8.42E+02	7.24E+01	7.24E+01

Table 6: Environmental impacts, 1 m³ of dressed, kiln-dried softwood.

	Production	Landfill (typical)	Landfill (NGA)	Energy recovery	Recycling
Parameter [Unit]	**A1-A3**	**C4**	**C4**	**C3**	**C3**
GWPIB [kg CO_2-eq.]	-6.31E+02	6.12E+01	7.49E+02	9.06E+02	9.06E+02
GWPEB [kg CO_2-eq.]	2.69E+02	6.04E+01	5.45E+02	5.62E+00	5.62E+00
ODP [kg CFC11-eq.]	4.23E-09	5.26E-10	5.26E-10	1.78E-10	1.78E-10
AP [kg SO_2-eq.]	1.33E+00	1.83E-01	2.28E-01	8.91E-01	3.57E-02
EP [kg PO_4^{3-}-eq.]	3.65E-01	2.32E-02	3.45E-02	1.79E-01	8.45E-03
POCP [kg C_2H_4-eq.]	5.43E-01	1.68E-02	1.51E-01	9.54E-02	3.78E-03
ADPE [kg Sb-eq.]	4.31E-05	1.12E-05	1.13E-05	9.40E-08	9.40E-08
ADPF [MJ]	3.11E+03	8.42E+02	8.42E+02	7.24E+01	7.24E+01

Resource Use

Table 7: Resource use, 1 m³ of sawn, kiln-dried softwood.

	Production	Landfill (typical)	Landfill (NGA)	Energy recovery	Recycling
Parameter [Unit]	**A1-A3**	**C4**	**C4**	**C3**	**C3**
PERE [MJ]	2.60E+03	4.21E+01	4.21E+01	9.29E+03	1.77E+00
PERM [MJ]	9.29E+03	0.00E+00	0.00E+00	-9.29E+03	-9.29E+03
PERT [MJ]	1.19E+04	4.21E+01	4.21E+01	1.77E+00	-9.29E+03
PENRE [MJ]	2.46E+03	8.61E+02	8.61E+02	7.24E+01	7.24E+01
PENRM [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT [MJ]	2.46E+03	8.61E+02	8.61E+02	7.24E+01	7.24E+01
SM [kg]	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
NRSF [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FWB [m^3]	9.39E-01	5.84E-03	8.24E-02	5.77E-01	1.50E-03
FWG [m^3]	3.24E+02	2.39E-01	2.39E-01	2.87E-02	2.87E-02
FWT [m^3]	3.25E+02	2.45E-01	3.21E-01	6.05E-01	3.02E-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 8: Resource use, 1 m³ of dressed, kiln-dried softwood.

	Production	Landfill (typical)	Landfill (NGA)	Energy recovery	Recycling
Parameter [Unit]	**A1-A3**	**C4**	**C4**	**C3**	**C3**
PERE [MJ]	3.04E+03	4.21E+01	4.21E+01	9.29E+03	1.77E+00
PERM [MJ]	9.29E+03	0.00E+00	0.00E+00	-9.29E+03	-9.29E+03
PERT [MJ]	1.23E+04	4.21E+01	4.21E+01	1.77E+00	-9.29E+03
PENRE [MJ]	3.13E+03	8.61E+02	8.61E+02	7.24E+01	7.24E+01
PENRM [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT [MJ]	3.13E+03	8.61E+02	8.61E+02	7.24E+01	7.24E+01
SM [kg]	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
NRSF [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FWB [m³]	1.21E+00	5.84E-03	8.24E-02	5.77E-01	1.50E-03
FWG [m³]	3.78E+02	2.39E-01	2.39E-01	2.87E-02	2.87E-02
FWT [m³]	3.79E+02	2.45E-01	3.21E-01	6.05E-01	3.02E-02

Waste and Output Flows

Table 9: Waste categories, 1 m³ of sawn, kiln-dried softwood.

	Production	Landfill (typical)	Landfill (NGA)	Energy recovery	Recycling
Parameter [Unit]	**A1-A3**	**C4**	**C4**	**C3**	**C3**
HWD [kg]	4.05E-04	1.41E-04	1.41E-04	1.25E-05	1.25E-05
NHWD [kg]	5.42E+01	5.52E+02	3.50E+02	4.26E-03	4.26E-03
RWD [kg]	5.57E-03	7.30E-03	7.30E-03	1.13E-05	1.13E-05
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	5.50E+02
MER [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE [MJ]	0.00E+00	8.02E-01	1.85E+02	3.04E+03	0.00E+00
EET [MJ]	0.00E+00	0.00E+00	0.00E+00	3.04E+03	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 10: Waste categories, 1 m³ of dressed, kiln-dried softwood.

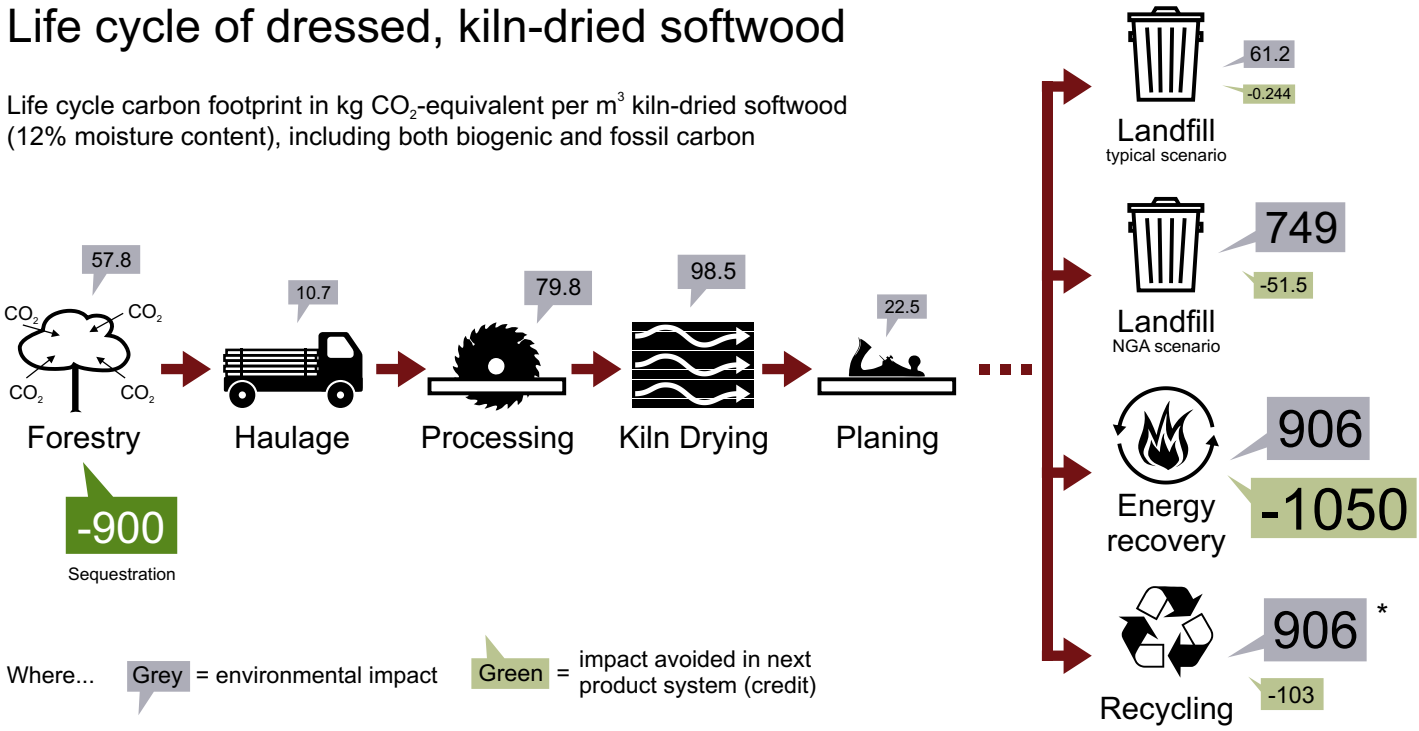
	Production	Landfill (typical)	Landfill (NGA)	Energy recovery	Recycling
Parameter [Unit]	**A1-A3**	**C4**	**C4**	**C3**	**C3**
HWD [kg]	5.17E-04	1.41E-04	1.41E-04	1.25E-05	1.25E-05
NHWD [kg]	6.32E+01	5.52E+02	3.50E+02	4.26E-03	4.26E-03
RWD [kg]	6.56E-03	7.30E-03	7.30E-03	1.13E-05	1.13E-05
CRU [kg]	0.00E+00	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	5.50E+02
MER [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE [MJ]	0.00E+00	8.02E-01	1.85E+02	3.04E+03	0.00E+00
EET [MJ]	0.00E+00	0.00E+00	0.00E+00	3.04E+03	0.00E+00

Interpretation

Understanding the Life Cycle of Softwood Timber

Life cycle of dressed, kiln-dried softwood

Life cycle carbon footprint in kg CO_2-equivalent per m^3 kiln-dried softwood (12% moisture content), including both 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 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_2) 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_2 sequestered per cubic metre of wood was calculated using the formula specified in European standard EN 16449:2014:

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

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)
- ω is the moisture content of the product on a dry basis (12% for kiln dry)
- ρ_ω is the density of woody biomass at that moisture content (kg/m^3) (550 kg/m^3 for kiln-dried softwood, based on weighted averages)
- V_ω 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_2 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 and 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 plantations and a base case land use (pasture) from the original CSIRO LCI study (CSIRO 2009). 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 the Australian timber and wood product EPDs produced in this series.

Other Environmental Information

Module D: Recycling, Reuse and Recovery Potentials

Table 11: Module D, 1 m³ of sawn, kiln-dried softwood.

Parameter [Unit]	Landfill (typical)	Landfill (NGA)	Energy recovery	Recycling
Environmental Impact				
GWPIB [kg CO_2-eq.]	-2.24E-01	-5.15E+01	-1.05E+03	-1.03E+02
GWPEB [kg CO_2-eq.]	-2.24E-01	-5.15E+01	-1.05E+03	-1.04E+02
ODP [kg CFC11-eq.]	-1.73E-13	-3.98E-11	-6.67E-10	-1.00E-09
AP [kg SO_2-eq.]	-9.81E-04	-2.26E-01	-4.02E+00	-8.97E-01
EP [kg PO_4^{3-}-eq.]	-8.22E-05	-1.89E-02	-3.84E-01	-1.77E-01
POCP [kg C_2H_4-eq.]	-5.31E-05	-1.22E-02	-2.29E-01	-1.13E-01
ADPE [kg Sb-eq.]	-5.90E-09	-1.36E-06	-3.46E-05	-6.38E-06
ADPF [MJ]	-2.53E+00	-5.81E+02	-1.30E+04	-1.38E+03
Resource Use				
PERE [MJ]	-1.66E-01	-3.81E+01	-6.29E+02	-2.72E+03
PERM [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT [MJ]	-1.66E-01	-3.81E+01	-6.29E+02	-2.72E+03
PENRE [MJ]	-2.53E+00	-5.82E+02	-1.30E+04	-1.39E+03
PENRM [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT [MJ]	-2.53E+00	-5.82E+02	-1.30E+04	-1.39E+03
SM [kg]	0.00E+00	0.00E+00	0.00E+00	5.50E+02
RSF [MJ]	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
FWB [m^3]	-1.25E-03	-2.87E-01	-4.74E+00	-7.37E-01
FWG [m^3]	-1.33E-04	-3.05E-02	-5.13E-01	-3.34E+01
FWT [m^3]	-1.38E-03	-3.17E-01	-5.25E+00	-3.41E+01
Wastes and Outputs				
HWD [kg]	-4.44E-07	-1.02E-04	-2.01E-03	-5.03E-03
NHWD [kg]	-5.92E-04	-1.36E-01	-2.82E+00	-5.78E+00
RWD [kg]	-7.44E-07	-1.71E-04	-2.96E-03	-3.18E-03
CRU [kg]	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
MER [kg]	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
EET [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 12: Module D, 1 m³ of dressed, kiln-dried softwood.

Parameter [Unit]	Landfill (typical)	Landfill (NGA)	Energy recovery	Recycling
Environmental Impact				
GWPIB [kg CO_2-eq.]	-2.24E-01	-5.15E+01	-1.05E+03	-1.03E+02
GWPEB [kg CO_2-eq.]	-2.24E-01	-5.15E+01	-1.05E+03	-1.04E+02
ODP [kg CFC11-eq.]	-1.73E-13	-3.98E-11	-6.67E-10	-1.00E-09
AP [kg SO_2-eq.]	-9.81E-04	-2.26E-01	-4.02E+00	-8.97E-01
EP [kg PO_43^--eq.]	-8.22E-05	-1.89E-02	-3.84E-01	-1.77E-01
POCP [kg C_2H_4-eq.]	-5.31E-05	-1.22E-02	-2.29E-01	-1.13E-01
ADPE [kg Sb-eq.]	-5.90E-09	-1.36E-06	-3.46E-05	-6.38E-06
ADPF [MJ]	-2.53E+00	-5.81E+02	-1.30E+04	-1.38E+03
Resource Use				
PERE [MJ]	-1.66E-01	-3.81E+01	-6.29E+02	-2.72E+03
PERM [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT [MJ]	-1.66E-01	-3.81E+01	-6.29E+02	-2.72E+03
PENRE [MJ]	-2.53E+00	-5.82E+02	-1.30E+04	-1.39E+03
PENRM [MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT [MJ]	-2.53E+00	-5.82E+02	-1.30E+04	-1.39E+03
SM [kg]	0.00E+00	0.00E+00	0.00E+00	5.50E+02
RSF [MJ]	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
FWB [m^3]	-1.25E-03	-2.87E-01	-4.74E+00	-7.37E-01
FWG [m^3]	-1.33E-04	-3.05E-02	-5.13E-01	-3.34E+01
FWT [m^3]	-1.38E-03	-3.17E-01	-5.25E+00	-3.41E+01
Wastes and Outputs				
HWD [kg]	-4.44E-07	-1.02E-04	-2.01E-03	-5.03E-03
NHWD [kg]	-5.92E-04	-1.36E-01	-2.82E+00	-5.78E+00
RWD [kg]	-7.44E-07	-1.71E-04	-2.96E-03	-3.18E-03
CRU [kg]	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
MER [kg]	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
EET [MJ]	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 which 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 softwood 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 seasoned sawn softwood products. These products will deliver a very long service life in most building, joinery and furniture applications where they are protected from termite attack and used inside a building envelope.

While the majority of seasoned sawn softwood produced in Australia for structural applications is untreated, a significant proportion is envelope treated in the factory to H2F hazard level for termite protection (see Table 2). Other seasoned sawn softwood products are subsequently treated with a range of preservatives for termite and decay protection to be used in outdoor applications such as decking, cladding, fencing and landscaping.

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

1. H2F treatment only penetrates a small distance into softwood and the preservative forms a protective envelope around the wood.

2. For outdoor applications, the sapwood (located on the outer part of the tree) is actually treated with preservative. Softwood species such as radiata pine have a large proportion of sapwood so preservative penetrates further into softwood. 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 that prevent the uptake of preservative solutions.

3. 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 (H2, H2F, H3, H4, H5 and H6, depending on the application). For more, see WoodSolutions (2015).

4. 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 softwoods for outdoor applications. Another common preservative used in Australia is Alkaline Copper Quaternary (ACQ); however, the EcoBalance study does not include data for ACQ. The common active ingredient in preservatives used in Australia for H2F termite protection are synthetic pyrethroids – most commonly applied in a water base. The EcoBalance study does not include data for any of these synthetic pyrethroid preservatives.

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Appendix 1 - FWPA Softwood Producer Members

Allied Timber Products Pty Ltd

Associated Kiln Driers Pty Ltd trading as A.K.D. Softwoods

Australian United Timbers Pty Ltd

Auswest

Boral Timber

Carter Holt Harvey Woodproducts Australia

D&R Hendersen Pty Ltd

Highland Pine Products Pty Ltd

Hyne Timber

Koppers Wood Products Pty Ltd

KSI Sawmills Pty Ltd

LM Hayter & Sons Pty Ltd

McDonnell Industries Pty Ltd trading as NF McDonnell & Sons

Penrose Pine Products Pty Ltd

SA Sawmilling Pty Ltd

Tarmac Sawmilling Pty Ltd

TASCO trading as Dongwha Timbers Pty Ltd

Timberlink Australia

Wespine Industries Pty Ltd

Whiteheads Timber Sales Pty Ltd