futurebuild LVL

APRIL 2023

# Laminated Veneer Lumber (LVL)

# ENVIRONMENTAL PRODUCT DECLARATION

**In accordance with ISO 14025 and EN15804+A2:2019**

| | |
|---|---|
| Programme: | The International EPD® System www.environdec.com |
| Programme operator: | EPD Australasia www.epd-australasia.com |
| EPD registration number: | S-P-05514 |
| Valid from: | 2023-04-12 |
| Valid until: | 2028-04-12 |
| Geographical scope: | New Zealand |

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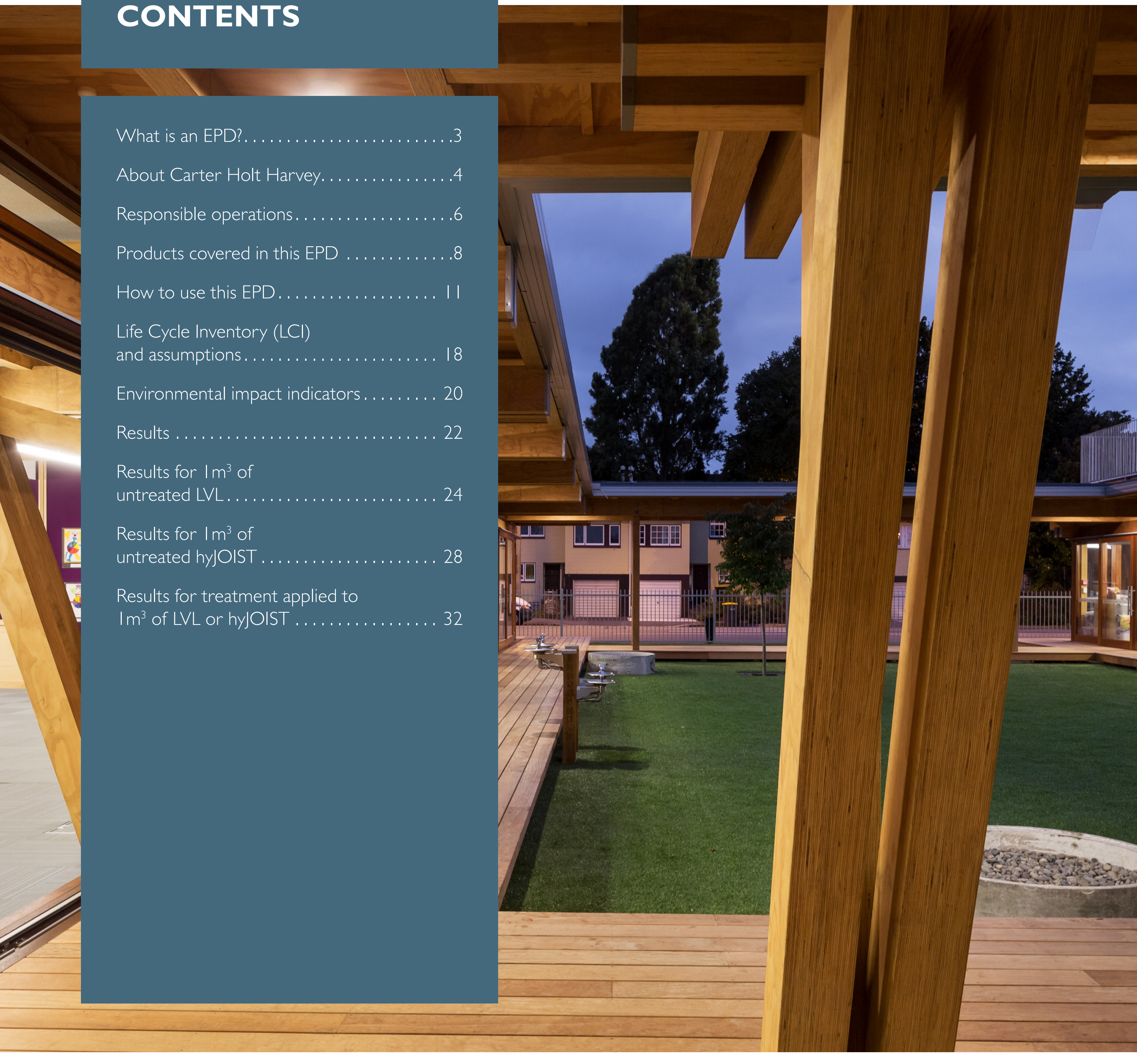

# WHAT IS AN EPD?

Carter Holt Harvey recognizes the importance of providing transparent and independently verified environmental impact information about its products. An Environmental Product Declaration (EPD) is a robust, science based, independently verified and standardized method for communicating the environmental impacts of products.

This EPD covers the environmental impacts of Carter Holt Harvey LVL for application both within and outside the building envelope subject to treatment level. The products are manufactured at Marsden Point, Northland, New Zealand within the Futurebuild® LVL mill.

This EPD is based on a cradle-to-gate Life Cycle Assessment (LCA), with end-of-life options included. 'Cradle' refers to the raw material extraction and 'the gate' is the gate of the Carter Holt Harvey LVL Marsden Point mill as the product is ready to go out to customers. Carter Holt Harvey LVL, as the EPD owner has the sole ownership, liability, and responsibility for the EPD. This EPD has been produced in accordance with a consistent set of rules known as product category rules (PCR). EPDs 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 EN15804+A2 or if they are produced using different product category rules.

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# ABOUT CARTER HOLT HARVEY

Carter Holt Harvey (CHH) is one of New Zealand's leading forest products companies, manufacturing and supplying timber, laminated veneer lumber (LVL), plywood and other building products to the New Zealand market.

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Carter Holt Harvey together with its legacy companies has been a feature of the Australasian timber industry for more than 150 years. Over the past decade, it has reconfigured its asset base through a combination of organic growth, capacity expansions at key sites and investment in technology. CHH has consistently introduced new processes to improve productivity, and kept the business streamlined by closing smaller, inefficient facilities.

Today, Carter Holt Harvey is organised into four business units: Carter Holt Harvey Building Products (CHH Timber), Carter Holt Harvey Plywood (CHH Plywood), Carter Holt Harvey LVL (Futurebuild® LVL) and Carters Building Supplies.

Futurebuild LVL offers the largest range of LVL products within New Zealand, which are used in projects across Australasia. Manufacturing LVL in the Marsden Point plant, Futurebuild LVL produces brands hySPAN®, hyJOIST®, hyONE®, hy90®, hyCHORD®, truFORM®, hyPLANK®, edgeFORM®, and hyFRAME® building systems.

## SUSTAINABLE GROWTH

Carter Holt Harvey takes a sustainable approach to the way the company operates and grows its business. The company's commitment to the environment is fundamental to its business. From the use of plantation forests to promoting polices minimizing waste and emissions, CHH is proud of the sustainable base for its products. CHH continually strives to be an outstanding business in everything the company does, from manufacturing to service delivery with sustainable solutions at the core of this.

The CHH EPDs are a demonstration of the continual focus and commitment to sustainability, through a science driven, independently verifiable process with standard methodology across all products.

CarterHoltHarvey

## BUSINESS UNITS

CHH Timber

CHH PLY

futurebuild LVL

CARTERS
Your Building Partner

# RESPONSIBLE OPERATIONS

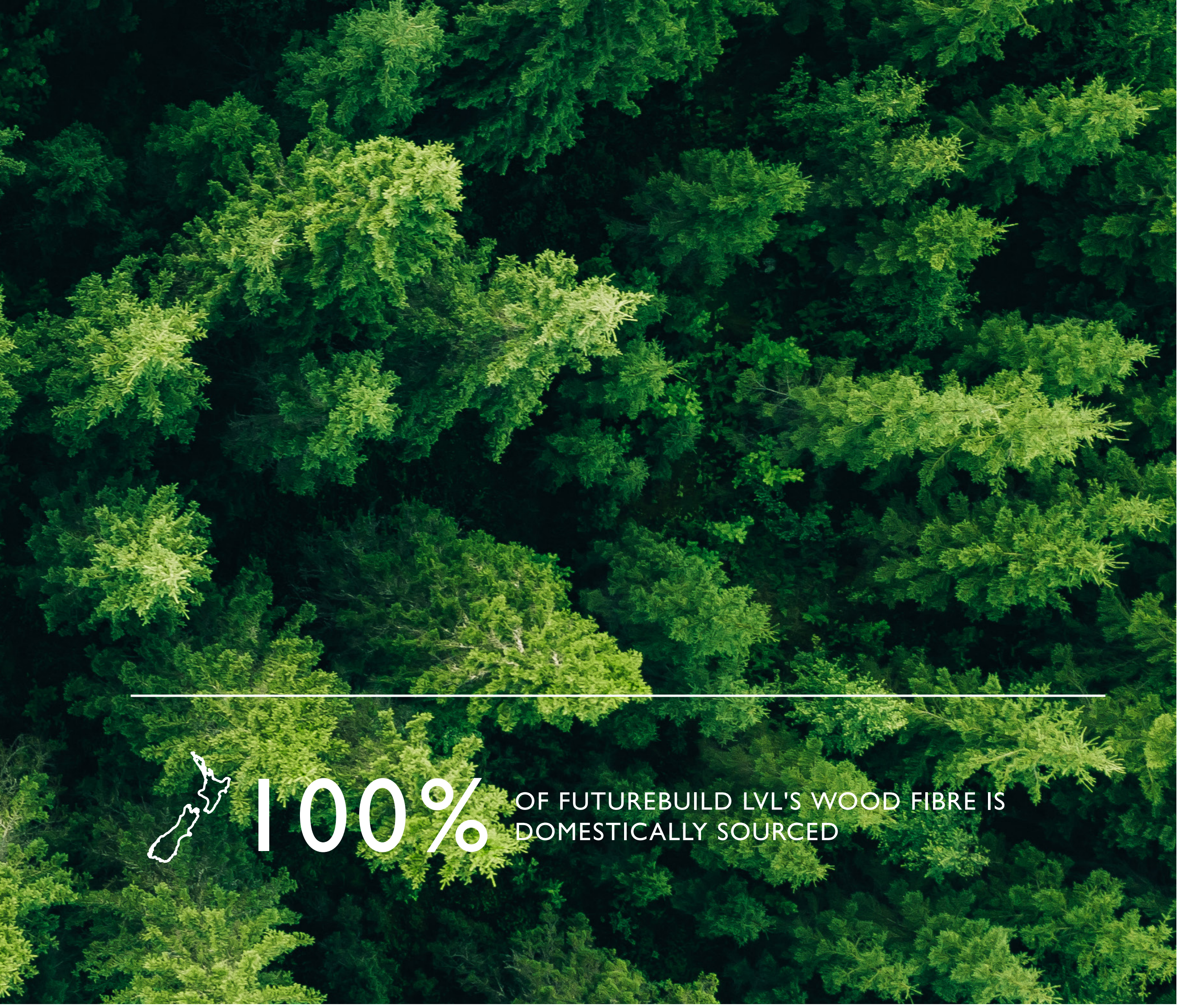

## FSC AND SUSTAINABILITY ACCREDITATIONS

Futurebuild LVL has been assessed by the Forest Stewardship Council®, a globally recognised independent body, and granted FSC® certification (FSC® C007103) for all its production sites. This certification commonly known as FSC has assessed and confirmed Futurebuild LVL's operation is using responsibly sourced wood. The certification also covers a verification program and a risk assessment for the control of wood sourced from New Zealand Pinus radiata plantations and Futurebuild LVL's internal process to manage this.

## THIRD PARTY QUALITY ASSURANCE PROGRAM

Futurebuild LVL has strict quality assurance processes in place to monitor that Futurebuild LVL is manufactured in a manner that meets both the structural and visual requirements of the specific product. Futurebuild LVL is independently third party audited by the EWPAA. The EWPAA certifies Futurebuild LVL manufactured at its Marsden Point mill. Participation and compliance with the requirements of the EWPAA's process-based quality control scheme includes product testing and monitoring of properties. It provides the basis for the EWPAA's Product Certification of Futurebuild LVL as conforming to the requirements of AS/NZS 4357. Conformance with AS/NZS 4357 ensures that Futurebuild LVL is suitable for structural applications in accordance with NZS 3603 and NZS 3604. The EWPAA's product certification scheme is accredited under JAS-ANZ.

Futurebuild LVL also has quality assurance processes in place to monitor that Futurebuild LVL products satisfy the requirements for treatment in accordance with AS/NZS 1604.4, Specification for preservative




treatment - Part 4: Laminated Veneer Lumber (and NZS 3640), as required by NZS 3602, Timber and Wood-based Products for use in Building. Independent Verification Services (IVS) has been contracted to undertake independent, third-party auditing of Futurebuild LVL's internal treatment processes at Futurebuild LVL's treatment sites. Independent audit inspections are carried out bi-annually and include an audit of the treatment process and procedures. IVS also complete the verification of each treatment batches/charges for compliance with NZS 3640, Chemical preservation of round and sawn timber

## FUTUREBUILD LVL AND THE ENVIRONMENT

Futurebuild LVL takes its environmental responsibility seriously by using waste handling procedures to optimise recovery and manage the use of arisings whilst limiting waste. This starts with the use of only radiata pine sourced from sustainably managed renewable plantation and includes the application of optimisation algorithms for veneer peeling to enhance finished goods recovery as well as the development of markets for the downgrading of arising product for use in industrial applications including packaging. Peeler cores are typically reprocessed for use as bearers whilst downgraded product is reprocessed into products including fillet sticks and bearers as well as being on-sold for use in furniture as applicable. All waste product derived is assessed for downstream applications including bark for landscaping, boiler fuel and/or sold for use in wood fibre products.

The Futurebuild LVL range of untreated and H1.2 treated products have been issued Declare labels and determined to be Red List Free through the International Living Future Institute, and as such the untreated and H1.2 treated range can be used in Living Building Challenge projects.

Formaldehyde Emissions for Futurebuild LVL products are measured as being less than 0.5 mg/L, classed as E0.

# PRODUCTS COVERED IN THIS EPD

## THIS EPD COVERS LAMINATED VENEER LUMBER (LVL) AND hyJOIST

Laminated veneer lumber, more commonly known as LVL, is an engineered wood product. Proven globally for over 30 years, LVL is made by peeling wood veneers and laminating them together under precise conditions.

Each wood veneer is tested to determine its properties, the veneers are then combined using different recipes based on the properties of the final product required. Heat, glue and pressure are used to combine the veneers. This results in a product which is solid, highly predictable and uniform.

The Futurebuild LVL range includes solid LVL sections ranging from a Modulus of Elasticity of 9.5 GPa through to 16.0 GPa. This includes hy90, hyCHORD, hySPAN and hyONE that are available off the shelf. Futurebuild LVL also includes a range of products for formwork and access solutions for temporary structures under the brand names truFORM, edgeFORM and hyPLANK. Products included in the EPD are H1.2 treated or untreated LVL, of varying thicknesses from 42 to 90mm nominal, manufactured at the Marsden Point mill.

The composite plywood/LVL i-beam, hyJOIST, (Treated or untreated, of varying dimension HJ200 45, HJ240 45, HJ240 63, HJ240 90, HJ300 45, HJ300 63, HJ300 90, HJ360 63, HJ360 90, HJ400 90) are also included in the EPD. Each of the LVL products has a defined set of characteristic structural values for application in specific engineering design or through Futurebuild LVL software and specification tools.

## PRODUCT APPLICATION

LVL is typically used as structural members for lintels, beams, mid-floors and roofs across residential projects. Futurebuild LVL is also suitable for use in commercial and industrial structures as both primary and secondary structural framing. Typically, H1.2 treated, Futurebuild LVL can also be supplied untreated to suit the target use and environment.

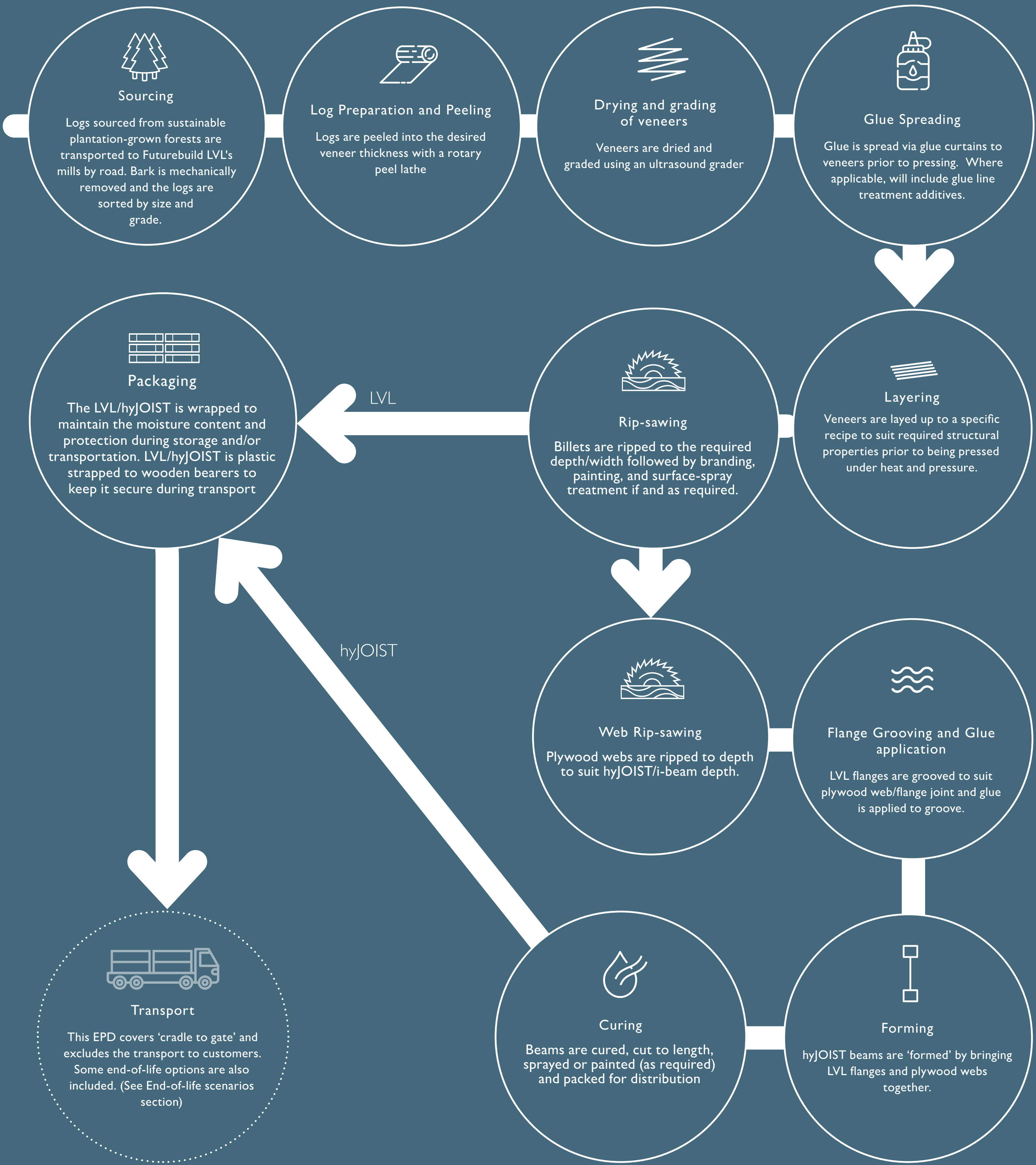
### Products, Software and Services

Futurebuild LVL has built a solutions-based platform for the supply of LVL across the New Zealand market with a fully integrated supply chain from design and specification through to 100% local manufacture and supply. The wider Futurebuild LVL offering includes software, Apps and specification tools for engineers, architects and building practitioners alike. It is supported by a range of services targeted at the optimisation and efficient design of the Futurebuild LVL range of products. All these solutions are tied together with supporting literature and quality control procedures ensuring that solutions aid builders and designers in optimised solutions that meet the requirements of the New Zealand Building Code.

### Biomass-fuels

Futurebuild LVL actively use waste material arising from processing activities as an energy source for all its boilers to generate heat used in kiln drying of veneers.

Figure 1. Manufacturing process (abridged)




Futurebuild LVL

# HOW TO USE THIS EPD

Carter Holt Harvey Futurebuild LVL has developed this average EPD to help to showcase the environmental credentials of Futurebuild LVL and hyJOIST. The EPD presents product weighted average results for both LVL and hyJOIST. The EPD also provides life cycle data for calculating the impacts of Futurebuild LVL and hyJOIST at a building level. This data may be used by specifiers and developers to calculate and present the environmental impacts of particular construction projects.

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This EPD can allow the represented products to qualify for points under green rating tools, such as the Green Star rating tool of the New Zealand Green Building Council (NZGBC).

New Zealand Green Building Council states:

> *"An EPD does not imply environmental superiority; it is solely a transparent declaration of the life-cycle environmental impact. The detailed, transparent environmental data that EPDs provide is an important step towards enabling whole-of-building life cycle assessment"*

The remainder of this EPD comprises 2 parts. Part one is the Technical Information for the method, assumptions, description of environmental indicators. Part two contains the results from modelling the life cycle assessment of the different products.

## DECLARED UNIT

# ONE CUBIC METRE OF LVL AND hyJOIST, AS SPECIFIED IN THE TABLE BELOW, PACKAGED AND READY FOR DISPATCH TO THE CONSUMER.

Table 1. Declared Unit

| Product Group | Unit | Product |
|---|---|---|
| LVL | 1m³ | Laminated timber (various thicknesses)<br>12% moisture content (dry basis), with an average density of 609/m³ |
| hyJOIST | 1m³ | hyJOIST (varying dimension)<br>With a density of 640 kg/m³ – presented as a production weighted average. |

## PRESERVATIVE TREATMENTS

LVL and hyJOIST products produced in New Zealand can be treated to help resist insect attack and/or fungal decay. Products to be used in outdoor applications are usually treated to the appropriate hazard class.

The LVL and hyJOIST products listed in Table 1 may be supplied in an untreated or treated form. The treatment types shown in Table 2 are used by Carter Holt Harvey Futurebuild LVL.

Table 2. Treatment class Treatment type Use

| Treatment class | Treatment type | Use |
|---|---|---|
| Untreated | none | Interior dry situations protected from weather and dampness, as prescribed in NZS 3602 |
| H1.2 | Triadimefon, Cyproconazole and Bifenthrin | Members protected by weather but with a risk of moisture penetration conducive to decay, as prescribed in NZS 3602 |

## CLASSIFICATION

Table 3 shows the classification codes and class descriptions of the products included within this EPD according to the UN CPC (Version 2.1) and ANZSIC 2006 classification systems.

**Table 3. Products included in this EPD**

| Product type | Classification | Code | Category |
|---|---|---|---|
| LVL and hyJOIST | UN CPC Ver.2.1 | 31421 | Other plywood, veneered panels and similar laminated wood, of coniferous wood |
| | ANZSIC 2006 | 1493 | Veneer and Plywood Manufacturing |

## PRODUCT COMPOSITION

Products included in this EPD are composed of kiln dried veneer, plywood and resin. The veneer and plywood is from Radiata Pine (Pinus radiata), grown within New Zealand in independent sustainably managed plantations and processed by Carter Holt Harvey.

Treated products in this EPD include those treated to H1.2 with Triadimefon, Cyproconazole and Bifenthrin

No products declared within this EPD contain substances exceeding the limits for registration according to the European Chemicals Agency's "Candidate List of Substances of Very High Concern for authorisation".

## SYSTEM BOUNDARIES

In Life Cycle Assessments (LCA), the system boundary is a line that divides the processes which are included from those which are excluded.

As shown in Table 4 this EPD is 'cradle-to-gate' with modules C1-C4 (end-of-life processing) and module D (recycling potential).

Other life cycle stages (Modules A4-A5 and B1-B7) are dependent on particular scenarios and best modelled at the building level, therefore these modules have not been declared.

**Table 4. Modules included in the scope of the EPD (X = declared module | MND = module not declared)**

| | Product stage | | | Construction process stage | | Use stage | | | | | | | End-of-life | | | | Recovery |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Raw material supply | Transport | Manufacturing | Transport | Construction Installation | Use | Maintenance | Repair | Replacement | Refurbishment | Operational energy use | Operational water use | Deconstruction / demolition | Transport | Waste processing | Disposal | Future reuse, recycling or energy recovery potential |
| Module | A1 | A2 | A3 | A4 | A5 | B1 | B2 | B3 | B4 | B5 | B6 | B7 | C1 | C2 | C3 | C4 | D |
| Modules declared | X | X | X | ND | ND | ND | ND | ND | ND | ND | ND | ND | X | X | X | X | X |
| Geography | NZ | NZ | NZ | - | - | - | - | - | - | - | - | - | NZ | NZ | NZ | NZ | NZ |
| Specific data | | | >90% | | | - | - | - | - | - | - | - | - | - | - | - | - |
| Variation – products | | | <10% | | | - | - | - | - | - | - | - | - | - | - | - | - |
| Variation - sites | | | Not relevant | | | - | - | - | - | - | - | - | - | - | - | - | - |

## END OF LIFE

At the end of its useful life, LVL and hyJOIST products are removed from the building and may end up recycled, reused, combusted to produce energy, or landfilled. In New Zealand, the most common end-of-life method is landfill, especially for treated products, which have limitations for recycling and incinerating.

The landfill scenario and three other possible end of life scenarios are described below. 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 specific data are available, the 'landfill' scenario should be used.

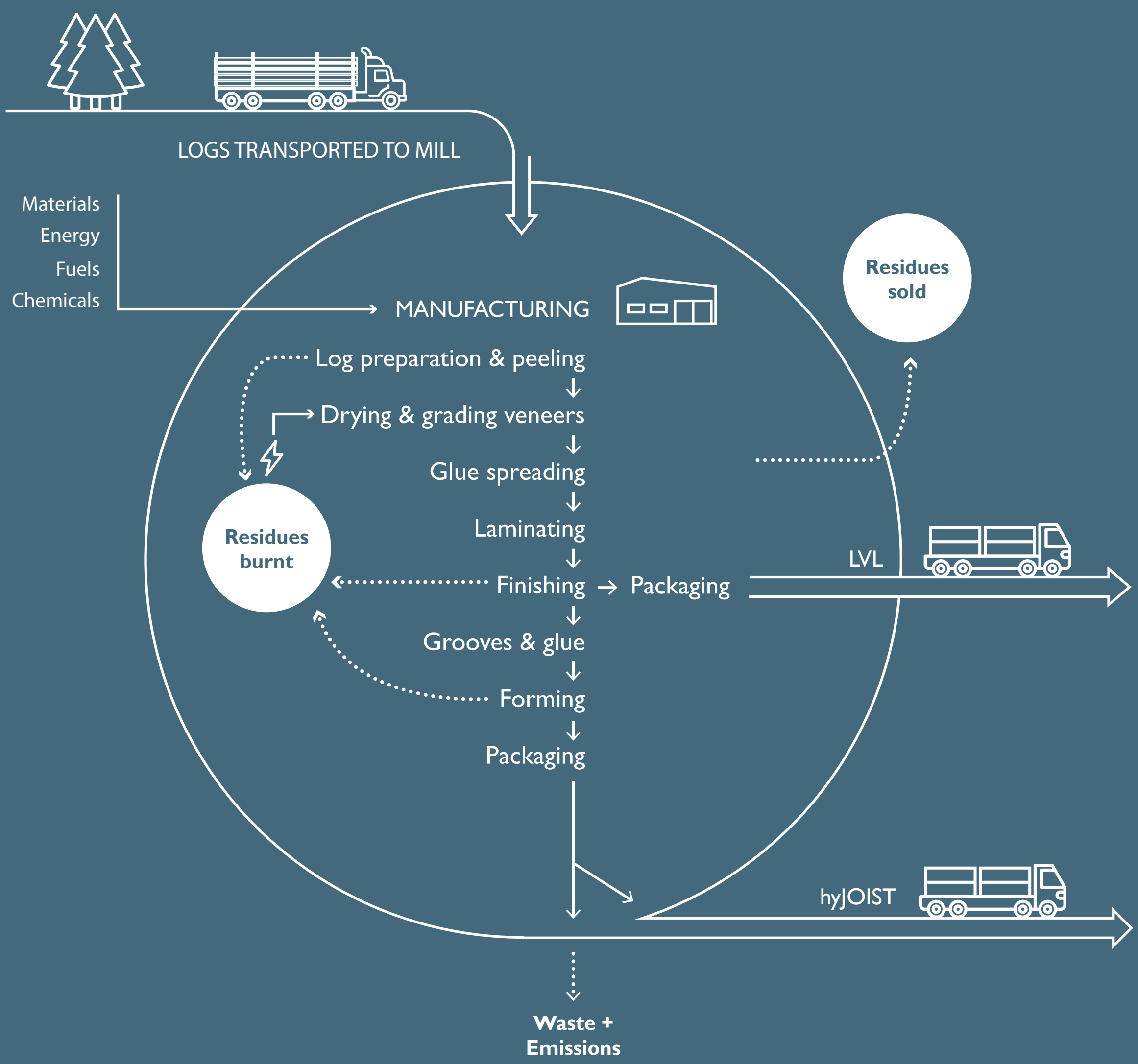
Under EN 15804+A2, the carbon sequestration of LVL and hyJOIST has a net neutral impact over the whole life cycle because all sequestered carbon is released at the end-of-life stage. This means that assumptions of the decomposition of wood products and various end-of-life scenarios all have the same effect in terms of biogenic carbon.

# PRODUCTION (MODULES A1-A3)

For all products in this EPD, the production stage includes the forestry, peeling, kiln drying and laminating stages. It also includes treatment for the applicable products.

Figure 2 shows the basic manufacturing processes for the products included within this EPD.

Figure 2. Manufacturing (A1-A3) process flowchart



## LANDFILL

Emissions from landfill are dependent on the Degradable Organic Carbon fraction (DOCf).

The DOCf = 0.1% for radiata pine. This is based on bioreactor laboratory research by Wang et al. (2011) for **Pinus radiata**. 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 2014, p. 189) and the resulting electricity receives a credit for offsetting average electricity from the New Zealand grid (module D) in line with EN 16485:2014 (Section 6.3.4.5).

The landfill scenario assumes the following for carbon emissions:

- Of the carbon in the wood that breaks down in landfill, 50% is methane and 50% is carbon dioxide (Australian Government 2016, Table 43).
- All carbon dioxide is released directly to the atmosphere.
- 53% of the methane is captured, (MfE, 2019).
- Of the 53% captured, one quarter (13% of the total) is flared, and three quarters (40% of the total) is used for energy recovery (Carre, 2011).
- Of the 47% of methane that is not captured, 10% (5% of the total) is oxidised (released as carbon dioxide) (Australian Government, 2016a) and 90% (42% of the total) is released into the atmosphere as methane.
- In summary, for every kilogram of carbon converted to landfill gas, 80 % is released as carbon dioxide and 20% is released as methane.

In accordance with EN 15804+A2, any remaining biogenic carbon not degraded (99.9% of the carbon in the wood) is modelled as an emission of biogenic CO2 to the air. Refer to the Additional Environmental Information section for information on permanent storage of biogenic carbon in radiata pine in landfill.

## ENERGY RECOVERY

This scenario includes shredding (module C3) and combustion with the recovered thermal energy assumed to replace thermal energy from natural gas (module D) in line with EN 16485:2014 (Section 6.3.4.5). Note that other options may also be in use within New Zealand, including replacement of coal, replacement of electricity, and replacement of both electricity and thermal energy (via co-generation).

## REUSE

The product is assumed to be removed from a building manually and reused with no further processing (i.e. direct reuse). Transport and wastage are excluded and only one reuse cycle is considered. The second life is assumed to be the same (or very similar) to the first, meaning that a credit is given for production of 1m³ of LVL and hyJOIST in module D. The $CO_2$ sequestered, and energy content of the wood are assumed to leave the system boundary at module C3 so that future product systems can also claim these without double-counting in line with EN 16485:2014 (Section 6.3.4.2). Any further processing, waste or transport would need to be modelled and included separately.

## RECYCLING

LVL and hyJOIST 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 virgin woodchips as a co-product from sawmilling (module D). In line with the reuse scenario, the $CO_2$ sequestered, and 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).

# LIFE CYCLE INVENTORY (LCI) AND ASSUMPTIONS

## ENERGY

Thermal energy and transport fuels have been modelled using the Australian average as no New Zealand specific datasets are available (see Sphera, 2021 for documentation).

Electricity for LVL and hyJOIST production (modules A1-A3) has been modelled with the New Zealand-specific grid mix.

The New Zealand national electricity grid production mix (Sphera 2021, electricity reference year 2018) is made up of hydro (57.02%), geothermal (17.9%) natural gas (15.97%), wind (4.85%), hard coal gases (1.44%) hard coal (1.26%), biomass (0.74%), biogas (0.59%), and photovoltaics (0.17%), lignite (0.05%) and fuel oil (0.01%).The emission factor for the New Zealand national grid for the GWP-GHG indicator is 0.145 kg CO2e/kWh.

## FORESTRY

Modelling of carbon flows in the forest has been performed in line with New Zealand's Greenhouse Gas Inventory (MfE, 2021).

Forestry is modelled as being in a steady-state, meaning that – on average – all harvested trees are replanted and that soil carbon stocks remain constant over time at the national level (MfE, 2021).

Biodegradation of forest litter and forest residues are modelled as being aerobic (MfE, 2021) and therefore carbon neutral as carbon dioxide sequestered from the air during tree growth is later released back to the air as carbon dioxide.

## ALLOCATION

### Upstream data

For refinery products, allocation is applied by mass and net calorific value.

### Co-products

These include bark, woodchips, sawdust and shavings. As the difference in economic value of the co-products is high (>25% as per EN 15804, Section 6.4.3.2), allocation by economic value has been applied.

## 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 (EPD International, 2019, Section 7.5.4). All other reported data were incorporated and modelled using the best available life cycle inventory data.

## PRIMARY DATA

Primary data for forestry, peeling, drying, pressing, finishing, packaging and treatment was collected from Carter Holt Harvey LVL plant in Marsden Point, Northland, New Zealand.

## REPRESENTATIVENESS

### Geographical

All primary and secondary data were collected specific to the countries or regions under study. Where country-specific or region-specific data were unavailable, proxy data were used. Geographical representativeness is considered to be high.

### Temporal

Primary data for forestry, peeling, drying, pressing, finishing, packaging and treatment was collected for the 12 month period from 1st January 2020 to 31st December 2020. All secondary data come from the GaBi 2021 databases and are representative of the years 2015-2020.

Long-term emissions (>100 years) are not taken into consideration in the impact estimate. Waste to landfill is modelled assuming a 100-year time horizon.

### Technological

All primary and secondary data were modelled to be specific to the technologies or technology mixes under study. Where technology-specific data were unavailable, proxy data were used. Technological representativeness is considered to be high.

### Other Environmental information.

When timber is landfilled any carbon not degraded can be expected to remain stored in the wood indefinitely under anaerobic conditions (Wang 2011 and Ximenes et al 2019). For Futurebuild untreated LVL this would result in a reduction of the GWP (biogenic) and GWP (total) for module C4 for the "landfill (typical)" scenario of 920 kg $CO_2$ eq so that the module C4 total GWP (biogenic) is 3 kg $CO_2$ eq.

# ENVIRONMENTAL IMPACT INDICATORS

An introduction to the core environmental impact indicators is provided below. The best-known effect of each indicator is listed in the descriptions and the abbreviations, in brackets, correspond to the labels in the following results tables.

### CLIMATE CHANGE (GLOBAL WARMING POTENTIAL)

(GWP-total, GWPf, GWPb, GWPluc)

A measure of greenhouse gas emissions, such as $CO_2$ and methane. These emissions are causing an increase in the absorption of radiation emitted by the earth, increasing the natural greenhouse effect. This may in turn have adverse impacts on ecosystem health, human health and material welfare. The Global Warming Potential (GWP) is split into three sub indicators: total (GWPt), fossil (GWPf), biogenic (GWPb), and land-use and land-use change (GWPluluc).

### OZONE DEPLETION POTENTIAL (ODP)

Depletion of the ozone leads to higher levels of UVB ultraviolet rays reaching the earth's surface with detrimental effects on humans and plants. The Ozone Depletion Potential is a measure of air emissions that contribute to the depletion of the stratospheric ozone layer.

### ACIDIFICATION POTENTIAL (AP)

Acidification Potential is a measure of emissions that cause acidifying effects to the environment. A molecule's acidification potential indicates its 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-fw, EP-fm, EP-tr)

Eutrophication covers all potential impacts of excessively high levels of macronutrients, the most important of which are nitrogen (N)and phosphorus (P). In aquatic ecosystems where this term is mostly applied, this typically describes a degradation in water quality. Eutrophication can result in an undesirable change in the type of species that flourish and an increase in the production of biomass. As the decomposition of biomass consumes oxygen, eutrophication may decrease the available oxygen level in the water column and threaten fish in their ability to respire.

## PHOTOCHEMICAL OZONE FORMATION POTENTIAL (POCP)

Photochemical Ozone Formation Potential gives an indication of the emissions from precursors that contribute to ground level smog formation, mainly ozone (O3). Ground level ozone may be harmful to human health and ecosystems and may also damage crops. These emissions are produced by the reaction of volatile organic compounds (VOCs) and carbon monoxide in the presence of nitrogen oxides and UV light.

## ABIOTIC RESOURCE DEPLETION (ADP-mm, ADPf)

The consumption of non-renewable resources decreases the availability of these resources and their associated functions in the future. Depletion of mineral resources and non-renewable energy resources are reported separately. Depletion of mineral resources is assessed based on total reserves.

## WATER USE (WDP)

Water scarcity is a measure of the stress on a region due to water consumption.

# RESULTS

The following tables show the results grouped in seven categories, each looking at different types of indicators. The headings below provide descriptions for each of these categories. Each column of numbers represents one declared unit: $1m^3$ of LVL or hyJOIST, packaged and ready for dispatch to the consumer.

The first row of the Environmental impact indicators, the Global Warming Potential (total) (GWPT) represents the total carbon footprint of the product. This is the sum of the biogenic carbon footprint (GWPB), mostly from the sequestration of carbon in wood, and the fossil carbon footprint (GWPF), which is mostly from the fossil fuels combusted during the production of the product. It should be noted that the GWPB is largely dependent on the density of the wood, which can vary by a large degree due to a range of factors.

For LVL or hyJOIST products, the most common value used for the carbon footprint in ratings tools like Green Star and eTool is the GWPF.

To assess treated product, the indicators for the specific treatment type should be combined with those of the product in question.

## ENVIRONMENTAL IMPACT EN15804+A2

The reported impact categories represent impact potentials, i.e., they are approximations of environmental impacts that could occur if the emissions would (a) follow the underlying impact pathway and (b) meet certain conditions in the receiving environment while doing so. The environmental impact results are therefore relative expressions only and do not predict actual impacts, the exceeding of thresholds, safety margins, or risks.

Long-term emissions (>100 years) are not taken into consideration in the impact estimate.

## RESOURCE USE

The resource use indicators describe the use of renewable and non-renewable material resources, renewable and non-renewable primary energy and water.

Note: 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), as 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).

## WASTE AND OUTPUT FLOW

Waste indicators describe waste generated within the life cycle of the product. Waste is categorised by hazard class, end of life fate and exported energy content.

## BIOGENIC CARBON INDICATORS

Biogenic carbon refers to the carbon stored in organic materials. This is sequestered during growth and released at end of life. EN15804+A2 requires the declaration of biogenic carbon content of the product and its packaging.

## ADDITIONAL ENVIRONMENTAL IMPACT INDICATORS

These indicators are voluntarily included to facilitate modularity where an EPD is used as input data for creating another EPD downstream in the value chain (EPD International, 2021).

## ENVIRONMENTAL IMPACT EN15804+A1

EN 15804+A1 core environmental impact categories aid with historical comparison and are used within various rating tools.

## GREEN STAR

These impact indicators comply with the Additional Life Cycle Impact Reporting requirement listed within the Green Star rating tools for Australia – Green Star Buildings v1, and Greenstar Design and As Built – as well as for New Zealand - Design and As Built Life Cycle Assessment Calculator NZv1.0. (Green Building Council of Australia, 2017; New Zealand Green Building Council, 2019).

# RESULTS FOR 1m³ OF UNTREATED LVL

Table 5. Environmental impact (EN15804+A2) covering modules A1-D

| | | | A1-A3 | C1 | C2 | C3 | C3 | C4 | C3 | D | D | D | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| INDICATOR | | UNIT | Production | Decon-struction | Transport to EOL | Recycling | Energy recovery | Landfill (typical) | Reuse | Recycling | Energy recovery | Landfill (typical) | Reuse |
| GWP | Global warming potential | kg $CO_2$ eq | -830 | 0.363 | 1.85 | 929 | 929 | 979 | 923 | -21.9 | -641 | 0 | -93.5 |
| GWPf | Global warming potential (fossil) | kg $CO_2$ eq | 91.4 | 0.363 | 1.77 | 5.84 | 5.84 | 56.3 | 0 | -21.3 | -643 | 0 | -91.4 |
| GWPb | Global warming potential (biogenic) | kg $CO_2$ eq | -921 | -3.71E-04 | 0.0782 | 923 | 923 | 923 | 923 | -0.579 | 1.86 | 0 | -2.06 |
| GWPluc | Global warming potential (land use change) | kg $CO_2$ eq | 0.0361 | 7.31E-06 | 2.77E-05 | 1.70E-04 | 1.70E-04 | 0.0414 | 0 | -0.00872 | -0.00835 | 0 | -0.0361 |
| ODP | Depletion potential of the stratospheric ozone layer | kg CFC 11 eq | 1.97E-10 | 5.34E-17 | 2.07E-16 | 8.45E-16 | 8.45E-16 | 1.39E-13 | 0 | -6.95E-12 | -1.41E-14 | 0 | -1.97E-10 |
| AP | Acidification potential - terrestrial and freshwater | Mol H+ eq | 0.929 | 0.00182 | 0.00543 | 0.0515 | 0.0515 | 0.196 | 0 | -0.313 | -0.0880 | 0 | -0.929 |
| EPfw | Eutrophication potential - freshwater | kg P eq | 1.00E-04 | 5.97E-08 | 3.23E-07 | 9.81E-07 | 9.81E-07 | 3.79E-05 | 0 | -5.22E-05 | -1.11E-05 | 0 | -1.00E-04 |
| EPm | Eutrophication potential - marine | kg N eq | 0.419 | 8.64E-04 | 0.00261 | 0.0250 | 0.0250 | 0.0555 | 0 | -0.124 | -0.132 | 0 | -0.419 |
| EPt | Eutrophication potential - terrestrial | Mol N eq | 4.59 | 0.00947 | 0.0287 | 0.275 | 0.275 | 0.607 | 0 | -1.50 | -1.45 | 0 | -4.59 |
| POFP | Photochemical ozone formation potential | kg NMVOC eq | 1.39 | 0.00242 | 0.00504 | 0.0693 | 0.0693 | 0.158 | 0 | -0.528 | -0.182 | 0 | -1.39 |
| ADPmm* | Abiotic depletion potential – minerals & metals | kg Sb eq | 3.52E-05 | 5.61E-09 | 2.99E-08 | 8.91E-08 | 8.91E-08 | 5.43E-06 | 0 | -1.09E-06 | -7.57E-05 | 0 | -3.52E-05 |
| ADPf* | Abiotic depletion potential – fossil fuels | MJ | 1,190 | 4.82 | 24.4 | 76.1 | 76.1 | 806 | 0 | -117 | -11,000 | 0 | -1,190 |
| WDP* | Water scarcity | m³ world eq | 26.1 | 0.00238 | 0.0143 | 0.0377 | 0.0377 | -0.920 | 0 | -11.9 | -0.533 | 0 | -26.1 |

*The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experience with the indicator.

## RESULTS FOR 1 m³ OF UNTREATED LVL CONTINUED

Table 6. Resource use indicators results covering modules A1-D

| INDICATOR | | UNIT | A1-A3 Production | C1 Decon-struction | C2 Transport to EOL | C3 Recycling | C3 Energy recovery | C4 Landfill (typical) | C3 Reuse | D Recycling | D Energy recovery | D Landfill (typical) | D Reuse |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PERE | Renewable primary energy as energy carrier | MJ | 4,190 | 0.0235 | 0.104 | 0.378 | 0.378 | 81.7 | 0 | -2,400 | -4.37 | 0 | -4,190 |
| PERM | Renewable primary energy resources as material utilization | MJ | 9,530 | 0 | 0 | -9,530 | -9,530 | 0 | -9,530 | 0 | 0 | 0 | 0 |
| PERT | Total use of renewable primary energy resources | MJ | 13,700 | 0.0235 | 0.104 | -9,530 | -9,530 | 81.7 | -9,530 | -2,400 | -4.37 | 0 | -4,190 |
| PENRE | Non-renewable primary energy as energy carrier | MJ | 1,190 | 4.82 | 24.4 | 76.1 | 76.1 | 806 | 0 | -117 | -11,000 | 0 | -1,190 |
| PENRM | Non-renewable primary energy as material utilization | MJ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PENRT | Total use of non-renewable primary energy resources | MJ | 1,190 | 4.82 | 24.4 | 76.1 | 76.1 | 806 | 0 | -117 | -11,000 | 0 | -1,190 |
| SM | Use of secondary material | kg | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 564 | 0 | 0 | 564 |
| RSF | Use of renewable secondary fuels | MJ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9,530 | 0 | 0 |
| NRSF | Use of non-renewable secondary fuels | MJ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| FW | Use of net fresh water | m³ | 2.18 | 4.67E-05 | 2.14E-04 | 7.44E-04 | 7.44E-04 | 0.0620 | 0 | -0.657 | -0.0161 | 0 | -2.18 |

Table 7. Waste categories and output flow indicators covering modules A1-D

| INDICATOR | | UNIT | A1-A3 Production | C1 Decon-struction | C2 Transport to EOL | C3 Recycling | C3 Energy recovery | C4 Landfill (typical) | C3 Reuse | D Recycling | D Energy recovery | D Landfill (typical) | D Reuse |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HWD | Hazardous waste disposed | kg | 1.97E-06 | 1.74E-11 | 7.35E-11 | 6.80E-08 | 6.80E-08 | 8.05E-08 | 0 | -1.11E-07 | -8.19E-07 | 0 | -1.97E-06 |
| NHWD | Non-hazardous waste disposed | kg | 16.9 | 1.15E-04 | 3.87E-04 | 0.00183 | 0.00183 | 566 | 0 | -5.74 | 26.2 | 0 | -16.9 |
| RWD | Radioactive waste disposed | kg | 0.00484 | 6.64E-07 | 5.72E-07 | 1.05E-05 | 1.05E-05 | 0.00421 | 0 | -7.36E-05 | -7.74E-04 | 0 | -0.00484 |
| CRU | Components for re-use | kg | 0 | 0 | 0 | 0 | 0 | 0 | 564 | 0 | 0 | 0 | -564 |
| MFR | Materials for recycling | kg | 0 | 0 | 0 | 564 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MER | Materials for energy recovery | kg | 0 | 0 | 0 | 0 | 564 | 0 | 0 | 0 | 0 | 0 | 0 |
| EEE | Exported electrical energy | MJ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EET | Exported thermal energy | MJ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

# RESULTS FOR 1m³ OF UNTREATED LVL CONTINUED

| Indicator | | Unit | A1-A3 Production | C1 Decon-struction | C2 Transport to EOL | C3 Recycling | C3 Energy recovery | C4 Landfill (typical) | C3 Reuse | D Recycling | D Energy recovery | D Landfill (typical) | D Reuse |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Table 8. Biogenic carbon content covering modules A1-D** | | | | | | | | | | | | | |
| BCC-prod | Biogenic carbon content - product | kg | 252 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -252 |
| BCC-pack | Biogenic carbon content - packaging | kg | 4.50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -4.50 |
| **Table 9. Additional Indicators covering modules A1-D** | | | | | | | | | | | | | |
| GWP-GHG | IPCC AR5 GWP (excluding biogenic carbon) | kg $CO_2$ eq | 87.3 | 0.362 | 1.77 | 5.81 | 5.81 | 56.1 | 0 | -18.7 | -646 | 0 | -87.3 |
| PM | Respiratory inorganics | Disease incidence | 1.61E-05 | 2.10E-08 | 2.83E-08 | 1.23E-06 | 1.23E-06 | 1.55E-06 | 0 | -5.65E-06 | 2.01E-05 | 0 | -1.61E-05 |
| IR# | Ionizing radiation - human health | kBq U235 eq | 0.551 | 7.79E-05 | 6.41E-05 | 0.00124 | 0.00124 | 0.391 | 0 | -0.0131 | -0.0945 | 0 | -0.551 |
| ETf* | Ecotoxicity freshwater | CTUe | 1,850 | 1.84 | 6.54 | 29.1 | 29.1 | 406 | 0 | -2,100 | -4,110 | 0 | -1,850 |
| HTc* | Human toxicity, cancer | CTUh | 1.77E-07 | 3.14E-11 | 1.11E-10 | 3.78E-09 | 3.78E-09 | 2.99E-08 | 0 | -3.89E-08 | -1.99E-08 | 0 | -1.77E-07 |
| HTnc* | Human toxicity, non-canc. | CTUh | 1.70E-05 | 1.61E-09 | 6.15E-09 | 3.07E-08 | 3.07E-08 | 2.89E-06 | 0 | -4.90E-06 | 3.64E-06 | 0 | -1.70E-05 |
| LU* | Land use | Dimensionless | 1,090 | 0.0124 | 0.0508 | 0.231 | 0.231 | 45.9 | 0 | -29.3 | -7.69 | 0 | -1,090 |
| **Table 10. Environmental impact (EN15804+A1) covering modules A1-D** | | | | | | | | | | | | | |
| GWP | Global warming potential (total) | kg $CO_2$ eq | -836 | 0.357 | 1.83 | 929 | 929 | 52.6 | 923 | -18.0 | 0 | 0 | -631 |
| ODP | Depletion potential of the stratospheric ozone layer | kg CFC-11 eq | 3.06E-10 | 7.13E-17 | 2.76E-16 | 1.13E-15 | 1.13E-15 | 1.85E-13 | 0 | -9.27E-12 | 0 | 0 | -1.88E-14 |
| AP | Acidification potential of land and water | kg $SO_2$ eq | 0.658 | 0.00128 | 0.00374 | 0.0357 | 0.0357 | 0.154 | 0 | -0.217 | 0 | 0 | -0.0199 |
| EP | Eutrophication potential | kg $(PO_4)^{3-}$ eq | 0.142 | 2.90E-04 | 8.81E-04 | 0.00839 | 0.00839 | 0.0192 | 0 | -0.0456 | 0 | 0 | -0.0449 |
| POCP | Photochemical ozone creation potential | kg Ethene eq | 0.260 | 1.20E-04 | -0.00145 | 0.00314 | 0.00314 | 0.00929 | 0 | -0.187 | 0 | 0 | 0.102 |
| ADPe* | Abiotic depletion potential – elements | kg Sb eq | 3.52E-05 | 5.62E-09 | 2.99E-08 | 8.92E-08 | 8.92E-08 | 5.46E-06 | 0 | -1.09E-06 | 0 | 0 | -7.57E-05 |
| ADPf* | Abiotic depletion potential – fossil fuels | MJ | 1,180 | 4.81 | 24.4 | 76.0 | 76.0 | 794 | 0 | -117 | 0 | 0 | -11,000 |

*The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experience with the indicator.

#This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon and from some construction materials is also not measured by this indicator

# RESULTS FOR 1m³ OF UNTREATED LVL CONTINUED

Table 11. Green Star covering modules A1-D

| | | | A1-A3 | C1 | C2 | C3 | C3 | C4 | C3 | D | D | D | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Indicator | | Unit | Production | Decon-struction | Transport to EOL | Recycling | Energy recovery | Landfill (typical) | Reuse | Recycling | Energy recovery | Landfill (typical) | Reuse |
| HTc | Human Toxicity | CTUh | 4.91E-06 | 1.25E-12 | 3.61E-12 | 3.30E-09 | 3.30E-09 | 2.51E-09 | 0.00E+00 | -3.60E-06 | 0.00E+00 | 0.00E+00 | 6.19E-09 |
| LU | Land use | kg C deficit eq. | -841 | 8.40E-04 | 0.00435 | 0.0175 | 0.0175 | 0.566 | 0 | -3.02 | 0 | 0 | -0.468 |
| GS-RDw | Resource depletion - water | m3 equiv | 0.170 | 3.02E-05 | 1.38E-04 | 4.79E-04 | 4.79E-04 | -0.0119 | 0 | -0.0980 | 0 | 0 | -0.00784 |
| IR# | Ionising Radiation | kBq U235 eq | 0.551 | 7.79E-05 | 6.40E-05 | 0.00124 | 0.00124 | 0.391 | 0 | -0.0131 | 0 | 0 | -0.0945 |
| PM | Particulate Matter | kg PM2,5-Equiv. | 0.0716 | 9.30E-05 | 1.46E-04 | 0.00526 | 0.00526 | 0.00853 | 0 | -0.0248 | 0 | 0 | 0.0890 |

#This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon and from some construction materials is also not measured by this indicator

# RESULTS FOR 1m³ OF hyJOIST

Table 12. Environmental impact (EN15804+A2) covering modules A1-D

| | | | A1-A3 | C1 | C2 | C3 | C3 | C4 | C3 | D | D | D | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| INDICATOR | | UNIT | Production | Decon-struction | Transport to EOL | Recycling | Energy recovery | Landfill (typical) | Reuse | Recycling | Energy recovery | Landfill (typical) | Reuse |
| GWP | Global warming potential | kg $CO_2$ eq | -747 | 0.403 | 2.06 | 1,030 | 1,030 | 1,080 | 1,030 | -21.9 | -712 | 0 | -279 |
| GWPf | Global warming potential (fossil) | kg $CO_2$ eq | 180 | 0.404 | 1.97 | 6.49 | 6.49 | 56.5 | 0 | -21.3 | -714 | 0 | -180 |
| GWPb | Global warming potential (biogenic) | kg $CO_2$ eq | -927 | -4.13E-04 | 0.0869 | 1,030 | 1,030 | 1,030 | 1,030 | -0.579 | 2.07 | 0 | -99.2 |
| GWPluc | Global warming potential (land use change) | kg $CO_2$ eq | 0.0621 | 8.13E-06 | 3.08E-05 | 1.89E-04 | 1.89E-04 | 0.0431 | 0 | -0.00872 | -0.00929 | 0 | -0.0621 |
| ODP | Depletion potential of the stratospheric ozone layer | kg CFC 11 eq | 2.22E-10 | 5.94E-17 | 2.30E-16 | 9.40E-16 | 9.40E-16 | 1.39E-13 | 0 | -6.95E-12 | -1.57E-14 | 0 | -2.22E-10 |
| AP | Acidification potential - terrestrial and freshwater | Mol H+ eq | 3.84 | 0.00203 | 0.00603 | 0.0573 | 0.0573 | 0.198 | 0 | -0.313 | -0.0979 | 0 | -3.84 |
| EPfw | Eutrophication potential - freshwater | kg P eq | 2.34E-04 | 6.64E-08 | 3.59E-07 | 1.09E-06 | 1.09E-06 | 3.85E-05 | 0 | -5.22E-05 | -1.23E-05 | 0 | -2.34E-04 |
| EPm | Eutrophication potential - marine | kg N eq | 1.70 | 9.61E-04 | 0.00290 | 0.0278 | 0.0278 | 0.0566 | 0 | -0.124 | -0.146 | 0 | -1.70 |
| EPt | Eutrophication potential - terrestrial | Mol N eq | 18.6 | 0.0105 | 0.0319 | 0.305 | 0.305 | 0.620 | 0 | -1.50 | -1.61 | 0 | -18.6 |
| POFP | Photochemical ozone formation potential | kg NMVOC eq | 5.18 | 0.00269 | 0.00560 | 0.0770 | 0.0770 | 0.162 | 0 | -0.528 | -0.203 | 0 | -5.18 |
| ADPmm* | Abiotic depletion potential – minerals & metals | kg Sb eq | 3.68E-05 | 6.24E-09 | 3.33E-08 | 9.91E-08 | 9.91E-08 | 5.45E-06 | 0 | -1.09E-06 | -8.41E-05 | 0 | -3.68E-05 |
| ADPf* | Abiotic depletion potential – fossil fuels | MJ | 1,780 | 5.36 | 27.1 | 84.6 | 84.6 | 809 | 0 | -117 | -12,300 | 0 | -1,780 |
| WDP* | Water scarcity | m³ world eq | 47.0 | 0.00264 | 0.0159 | 0.0419 | 0.0419 | -0.918 | 0 | -11.9 | -0.592 | 0 | -47.0 |

*The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experience with the indicator.

## Table 13. Resource use indicators results covering modules A1-D

| INDICATOR | | UNIT | A1-A3 Production | C1 Decon-struction | C2 Transport to EOL | C3 Recycling | C3 Energy recovery | C4 Landfill (typical) | C3 Reuse | D Recycling | D Energy recovery | D Landfill (typical) | D Reuse |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PERE | Renewable primary energy as energy carrier | MJ | 5,340 | 0.0261 | 0.116 | 0.421 | 0.421 | 81.8 | 0 | -2,400 | -4.85 | 0 | -5,340 |
| PERM | Renewable primary energy resources as material utilization | MJ | 10,600 | 0 | 0 | -10,600 | -10,600 | 0 | -10,600 | 0 | 0 | 0 | 0 |
| PERT | Total use of renewable primary energy resources | MJ | 15,900 | 0.0261 | 0.116 | -10,600 | -10,600 | 81.8 | -10,600 | -2,400 | -4.85 | 0 | -5,340 |
| PENRE | Non-renewable primary energy as energy carrier | MJ | 1,550 | 5.36 | 27.1 | 84.6 | 84.6 | 809 | 0 | -117 | -12,300 | 0 | -1,550 |
| PENRM | Non-renewable primary energy as material utilization | MJ | 233 | 0 | 0 | -233 | -233 | 0 | -233 | 0 | 0 | 0 | 0 |
| PENRT | Total use of non-renewable primary energy resources | MJ | 1,780 | 5.36 | 27.1 | -149 | -149 | 809 | -233 | -117 | -12,300 | 0 | -1,550 |
| SM | Use of secondary material | kg | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 627 | 0 | 0 | 627 |
| RSF | Use of renewable secondary fuels | MJ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10,600 | 0 | 0 |
| NRSF | Use of non-renewable secondary fuels | MJ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| FW | Use of net fresh water | m³ | 3.31 | 5.19E-05 | 2.38E-04 | 8.28E-04 | 8.28E-04 | 0.0622 | 0 | -0.657 | -0.0179 | 0 | -3.31 |

## Table 14. Waste categories and output flow indicators covering modules A1-D

| INDICATOR | | UNIT | A1-A3 Production | C1 Decon-struction | C2 Transport to EOL | C3 Recycling | C3 Energy recovery | C4 Landfill (typical) | C3 Reuse | D Recycling | D Energy recovery | D Landfill (typical) | D Reuse |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | -1.09E-06 | -8.41E-05 |
| HWD | Hazardous waste disposed | kg | 2.42E-06 | 1.93E-11 | 8.17E-11 | 7.56E-08 | 7.56E-08 | 8.07E-08 | 0 | -1.11E-07 | -9.10E-07 | 0 | -2.42E-06 |
| NHWD | Non-hazardous waste disposed | kg | 80.4 | 1.28E-04 | 4.30E-04 | 0.00203 | 0.00203 | 629 | 0 | -5.74 | 29.2 | 0 | -80.4 |
| RWD | Radioactive waste disposed | kg | 0.00723 | 7.39E-07 | 6.36E-07 | 1.17E-05 | 1.17E-05 | 0.00422 | 0 | -7.36E-05 | -8.61E-04 | 0 | -0.00723 |
| CRU | Components for re-use | kg | 0 | 0 | 0 | 0 | 0 | 0 | 627 | 0 | 0 | 0 | -627 |
| MFR | Materials for recycling | kg | 0 | 0 | 0 | 627 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MER | Materials for energy recovery | kg | 0 | 0 | 0 | 0 | 627 | 0 | 0 | 0 | 0 | 0 | 0 |
| EEE | Exported electrical energy | MJ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EET | Exported thermal energy | MJ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

# RESULTS FOR 1 m³ OF hyJOIST CONTINUED

| Indicator | | Unit | A1-A3 Production | C1 Decon-struction | C2 Transport to EOL | C3 Recycling | C3 Energy recovery | C4 Landfill (typical) | C3 Reuse | D Recycling | D Energy recovery | D Landfill (typical) | D Reuse |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Table 15. Biogenic carbon content covering modules A1-D** | | | | | | | | | | | | | |
| BCC-prod | Biogenic carbon content - product | kg | 255 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -255 |
| BCC-pack | Biogenic carbon content - packaging | kg | 10.7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10.7 |
| **Table 16. Additional Indicators covering modules A1-D** | | | | | | | | | | | | | |
| GWP-GHG | IPCC AR5 GWP (excluding biogenic carbon) | kg $CO_2$ eq | 167 | 0.402 | 1.96 | 6.46 | 6.46 | 56.3 | 0 | -18.7 | -718 | 0 | -167 |
| PM | Respiratory inorganics | Disease incidence | 7.40E-05 | 2.33E-08 | 3.15E-08 | 1.36E-06 | 1.36E-06 | 1.60E-06 | 0 | -5.65E-06 | 2.24E-05 | 0 | -7.40E-05 |
| IR# | Ionizing radiation - human health | kBq U235 eq | 0.873 | 8.66E-05 | 7.12E-05 | 0.00138 | 0.00138 | 0.391 | 0 | -0.0131 | -0.105 | 0 | -0.873 |
| ETf* | Ecotoxicity freshwater | CTUe | 3,140 | 2.05 | 7.27 | 32.3 | 32.3 | 408 | 0 | -2,100 | -4,570 | 0 | -3,140 |
| HTc* | Human toxicity, cancer | CTUh | 3.94E-07 | 3.49E-11 | 1.23E-10 | 4.20E-09 | 4.20E-09 | 2.99E-08 | 0 | -3.89E-08 | -2.22E-08 | 0 | -3.94E-07 |
| HTnc* | Human toxicity, non-canc. | CTUh | 3.16E-05 | 1.79E-09 | 6.83E-09 | 3.41E-08 | 3.41E-08 | 2.89E-06 | 0 | -4.90E-06 | 4.04E-06 | 0 | -3.16E-05 |
| LU* | Land use | Dimensionless | 2,550 | 0.0137 | 0.0565 | 0.257 | 0.257 | 46.9 | 0 | -29.3 | -8.55 | 0 | -2,550 |
| **Table 17. Environmental impact (EN15804+A1) covering modules A1-D** | | | | | | | | | | | | | |
| GWP | Global warming potential (total) | kg $CO_2$ eq | -771 | 0.397 | 2.03 | 1,030 | 1,030 | 52.8 | 1,030 | -18.0 | 0 | 0 | -701 |
| ODP | Depletion potential of the stratospheric ozone layer | kg CFC-11 eq | 3.36E-10 | 7.92E-17 | 3.07E-16 | 1.25E-15 | 1.25E-15 | 1.86E-13 | 0 | -9.27E-12 | 0 | 0 | -2.09E-14 |
| AP | Acidification potential of land and water | kg $SO_2$ eq | 2.74 | 0.00142 | 0.00416 | 0.0397 | 0.0397 | 0.155 | 0 | -0.217 | 0 | 0 | -0.0221 |
| EP | Eutrophication potential | kg $(PO_4)^{3-}$ eq | 0.571 | 3.22E-04 | 9.79E-04 | 0.00933 | 0.00933 | 0.0196 | 0 | -0.0456 | 0 | 0 | -0.0499 |
| POCP | Photochemical ozone creation potential | kg Ethene eq | 0.678 | 1.33E-04 | -0.00161 | 0.00350 | 0.00350 | 0.00946 | 0 | -0.187 | 0 | 0 | 0.114 |
| ADPe* | Abiotic depletion potential – elements | kg Sb eq | 3.68E-05 | 6.24E-09 | 3.33E-08 | 9.91E-08 | 9.91E-08 | 5.48E-06 | 0 | -1.09E-06 | 0 | 0 | -8.41E-05 |
| ADPf* | Abiotic depletion potential – fossil fuels | MJ | 1,760 | 5.35 | 27.1 | 84.5 | 84.5 | 797 | 0 | -117 | 0 | 0 | -12,200 |

*The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experience with the indicator.

# This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle.It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities.Potential ionizing radiation from the soil, from radon and from some construction materials is also not measured by this indicator

| | | | A1-A3 | C1 | C2 | C3 | C3 | C4 | C3 | D | D | D | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Indicator | | Unit | Production | Decon-struction | Transport to EOL | Recycling | Energy recovery | Landfill (typical) | Reuse | Recycling | Energy recovery | Landfill (typical) | Reuse |
| Table 18. Green Star covering modules A1-D | | | | | | | | | | | | | |
| HTc | Human Toxicity | CTUh | | | | | | | | | | | |
| LU | Land use | kg C deficit eq. | -688 | 9.34E-04 | 0.00484 | 0.0195 | 0.0195 | 0.652 | 0 | -3.02 | 0 | 0 | -0.520 |
| GS-RDw | Resource depletion - water | m3 equiv | 0.347 | 3.35E-05 | 1.54E-04 | 5.32E-04 | 5.32E-04 | -0.0118 | 0 | -0.0980 | 0 | 0 | -0.00872 |
| IR# | Ionising Radiation | kBq U235 eq | 0.873 | 8.66E-05 | 7.12E-05 | 0.00138 | 0.00138 | 0.391 | 0 | -0.0131 | 0 | 0 | -0.105 |
| PM | Particulate Matter | kg PM2,5-Equiv. | 0.329 | 1.03E-04 | 1.62E-04 | 0.00585 | 0.00585 | 0.00876 | 0 | -0.0248 | 0 | 0 | 0.0990 |

# This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle.It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities.Potential ionizing radiation from the soil, from radon and from some construction materials is also not measured by this indicator

# RESULTS FOR TREATMENT APPLIED TO 1m³ OF LVL OR hyJOIST

| | | | A1-A3 |
|---|---|---|---|
| INDICATOR | | UNIT | H1.2 |
| **Table 19. Environmental impact results covering modules A1-D** | | | |
| GWP | Global warming potential | kg $CO_2$ eq | 9.47 |
| GWPf | Global warming potential (fossil) | kg $CO_2$ eq | 9.39 |
| GWPb | Global warming potential (biogenic) | kg $CO_2$ eq | 0.0720 |
| GWPluc | Global warming potential (land use change) | kg $CO_2$ eq | 0.00849 |
| ODP | Depletion potential of the stratospheric ozone layer | kg CFC 11 eq | 8.89E-14 |
| AP | Acidification potential - terrestrial and freshwater | Mol H+ eq | 0.0374 |
| EPfw | Eutrophication potential - freshwater | kg P eq | 3.11E-05 |
| EPm | Eutrophication potential - marine | kg N eq | 0.00914 |
| EPt | Eutrophication potential - terrestrial | Mol N eq | 0.0957 |
| POFP | Photochemical ozone formation potential | kg NMVOC eq | 0.0272 |
| ADPmm* | Abiotic depletion potential – minerals & metals | kg Sb eq | 2.98E-04 |
| ADPf* | Abiotic depletion potential – fossil fuels | MJ | 208 |
| WDP | Water scarcity | m³ world eq | 361 |
| **Table 20. Resource use indicators results covering modules A1-D** | | | |
| PERE | Renewable primary energy as energy carrier | MJ | 60.1 |
| PERM | Renewable primary energy resources as material utilization | MJ | 0 |
| PERT | Total use of renewable primary energy resources | MJ | 60.1 |
| PENRE | Non-renewable primary energy as energy carrier | MJ | 208 |
| PENRM | Non-renewable primary energy as material utilization | MJ | 0 |
| PENRT | Total use of non-renewable primary energy resources | MJ | 208 |
| SM | Use of secondary material | kg | 0 |
| RSF | Use of renewable secondary fuels | MJ | 0 |
| NRSF | Use of non-renewable secondary fuels | MJ | 0 |
| FW | Use of net fresh water | m³ | 37.8 |

*The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experience with the indicator.

# RESULTS FOR TREATMENT APPLIED TO 1m$^3$ OF LVL OR hyJOIST CONTINUED

| INDICATOR | | UNIT | A1-A3 H1.2 |
|---|---|---|---|
| **Table 21. Waste categories and output flow indicators covering modules A1-D** | | | |
| HWD | Hazardous waste disposed | kg | 4.15E-08 |
| NHWD | Non-hazardous waste disposed | kg | 0.698 |
| RWD | Radioactive waste disposed | kg | 0.00282 |
| CRU | Components for re-use | kg | 0 |
| MFR | Materials for recycling | kg | 0 |
| MER | Materials for energy recovery | kg | 0 |
| EEE | Exported electrical energy | MJ | 0 |
| EET | Exported thermal energy | MJ | 0 |
| **Table 22. Biogenic carbon content covering modules A1-D** | | | |
| BCC-prod | Biogenic carbon content - product | kg | 0 |
| BCC-pack | Biogenic carbon content - packaging | kg | 0 |
| **Table 23. Additional Indicators covering modules A1-D** | | | |
| GWP-GHG | IPCC AR5 GWP (excluding biogenic carbon) | kg $CO_2$ eq | 9.40 |
| PM | Respiratory inorganics | Disease incidence | 4.55E-07 |
| IR# | Ionizing radiation - human health | kBq U235 eq | 0.248 |
| ETf* | Ecotoxicity freshwater | CTUe | 105 |
| HTc* | Human toxicity, cancer | CTUh | 2.97E-09 |
| HTnc* | Human toxicity, non-canc. | CTUh | 1.55E-07 |
| LU* | Land use | Dimensionless | 34.8 |
| **Table 24. Environmental impact (EN15804+A1) covering modules A1-D** | | | |
| GWP | Global warming potential (total) | kg $CO_2$ eq | 9.13 |
| ODP | Depletion potential of the stratospheric ozone layer | kg CFC-11 eq | 1.19E-13 |
| AP | Acidification potential of land and water | kg $SO_2$ eq | 0.0302 |
| EP | Eutrophication potential | kg $(PO_4)^{3-}$ eq | 0.00387 |
| POCP | Photochemical ozone creation potential | kg Ethene eq | 0.00322 |
| ADPe* | Abiotic depletion potential – elements | kg Sb eq | 2.98E-04 |
| ADPf* | Abiotic depletion potential – fossil fuels | MJ | 200 |
| **Table 25. Green Star covering modules A1-D** | | | |
| HT | Human Toxicity | CTUh | 1.42E-09 |
| LU | Land use | kg C deficit eq | 3.23 |
| GS-RDw | Resource depletion - water | m3 water use | 1.44 |
| IR# | Ionising Radiation | kBq U-235 eq | 0.248 |
| PM | Particulate Matter | kg PM2.5 eq | 0.00236 |

#This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon and from some construction materials is also not measured by this indicator

*The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experience with the indicator.

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# PROGRAMME-RELATED INFORMATION AND VERIFICATION

| | |
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