ENVIRONMENTAL PRODUCT DECLARATION

as per ISO 14025 and EN 15804

Owner of the Declaration	Sonae Arauco, S.A.
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-SON-20160211-IBA1-EN
Issue date	17-11-2016
Valid to	16-11-2021

Medium density fibreboard (MDF), coated with melamine impregnated paper

Sonae Arauco, S.A.

Institut Bauen und Umwelt e.V.

www.bau-umwelt.com / https://epd-online.com

1. General Information

Sonae Arauco, S.A.

Medium density fibreboard (MDF), coated with melamine impregnated paper

Programme holder
IBU - Institut Bauen und Umwelt e.V.
Panoramastr. 1
10178 Berlin
Germany

Owner of the Declaration
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Centro Empresarial Euronova
28760 Tres Cantos (Madrid)
España

Declaration number
EPD-SON-20160211-IBA1-EN

Declared product / Declared unit
Medium density fibreboard, coated with melamine impregnated paper, per m^2

This Declaration is based on the Product Category Rules:
Wood based panels, 07.2014
(PCR tested and approved by the SVR)

Scope:
This document refers to a representative sample of MDF manufactured in the following plants of the Sonae Arauco Group:

- Sonae Arauco Beeskow Holzwerkstoffe GmbH, Radinkendorfer Strasse 71, 15848 Beeskow, Germany
- Sonae Arauco Deutschland GmbH - Nettgau Plant, Strohmweg 1, 38489 Nettgau, Germany
- Sonae Arauco Portugal S.A., Quinta da Poça - S.Paio de Gramaços, 3404-954 Oliveira do Hospital, Portugal
- Sonae Arauco South Africa (Pty) Ltd, White River, South Africa
- Sonae Arauco España-Soluciones de Madera, S.L., Carretera Córdoba-Valencia Km 126, Estación Linares-Baeza, 23490 Linares (Jaén), Spain
- Sonae Arauco España-Soluciones de Madera, S.L., Calle de Los Titulos, 29, 47009 Valladolid, Spain

Issue date
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The production volume of these plants covers 100 % of the total production of coated MDF by Sonae Arauco group.The owner of the declaration shall be liable for the underlying information and evidence; the IBU shall not be liable with respect to manufacturer information, life cycle assessment data and evidences.

Verification

The CEN Norm /EN 15804/ serves as the core PCR
Independent verification of the declaration according to /ISO 14025/
☐ internally ☒ externally

Prof. Dr.-Ing. Horst J. Bossenmayer
(President of Institut Bauen und Umwelt e.V.)

Dr. Burkhart Lehmann
(Managing Director IBU)

Manfred Russ
(Independent verifier appointed by SVR)

2. Product

2.1 Product description

Medium density fibreboard (MDF) is a panel-shaped wood-based material in accordance with /EN 316/ that is manufactured in dry process by means of compression under heat of wood fibres with adhesive. Coated MDF boards can be profiled.

Due to their various densities and adhesive systems, they can display a variety of material properties and qualities like moisture resistance, fire retardant, load-bearing or others.

2.2 Application

The area of application for uncoated MDF primarily involves decorative interior furnishings and furniture construction but also interior construction such as trade fair stands and shop design.
When painted or coated, MDF can also be found in kitchens, offices, bedrooms and living rooms.

Apart from an extensive basic range, special MDF variants are also available, e.g. fire-retardant MDF as well as MDF with increased resistance to moisture.

2.3 Technical Data

Due to the large variability of product properties and quality grades, the table below only shows the range of technical characteristics for standard boards.

Special boards as well as customized products have different technical characteristics from the ones shown.

Name	Value	Unit
Gross density according to /EN 323/	750 - 860	kg/m^3
Bending strength (longitudinal) according to /EN 310/	17 - 23	N/mm^2
E-module (longitudinal) according to /EN 310/	1900 - 2700	N/mm^2
Material dampness at delivery according to /EN 322/	5 - 9	%
Tensile strength rectangular according to /EN 319/	0.5 - 0.65	N/mm^2
Thermal conductivity according to /EN 12524/	0.14	W/(mK)
Water vapour diffusion resistance factor according to /EN 12524/	15 - 50	-
Thickness swelling according to /EN 317/	8 - 17	%

Declaration of Performance (DoP)
For more details on technical information, please see the respective products' Declaration of Performance (DoP) available at:

www.sonaearauco.com/dop

2.4 Placing on the market / Application rules

For the placing on the market in the EU/EFTA (with the exception of Switzerland) the Regulation (EU) 305/2011 applies. The products need a Declaration of Performance (DOP) taking into consideration /EN 13986:2004+A1:2015 Wood-based panels for use in construction - Characteristics, evaluation of conformity and marking/ and the CE-marking.

For the application and use the respective national provisions apply.

Sonae Arauco MDF complies with the following product standards:

- /EN 316:2010/, Wood fibre boards
- /EN 622-1:2010/, Fibreboards
- /EN 622-5:2010/, Fibreboards
- /EN 13986:2005/, Wood-based panels for use in construction
- /ISO 16895-1:2008/, Wood-based panels
- /ISO 16895-2:2010/, Wood-based panels
- /EN 13171:2013/, Thermal insulation products for buildings
- /EN 14964:2006/, Rigid underlays for discontinuous roofing

2.5 Delivery status

MDF ranging in thicknesses from 2 to 50 mm can be purchased as uncoated boards. The boards are offered in standard formats. Fixed formats are also available, and selected formats are offered with a tongue and groove profile.

The following table includes minimum and maximum dimensions for the boards supplied worldwide. Some of the combinations for sizes may not be available in all markets.

Name	Min value	Max value	Unit
Thickness	2	50	mm
Width	590	2850	mm
Length	1025	6250	mm

For updated information on available dimensions, please refer to:

www.sonaearauco.com

2.6 Base materials / Ancillary materials

Coated MDF bonded with UF/MUF consist of (dimensions as % by mass):

- Wood chips, approx. 80%
- Water, 4-11%
- UF glue / MUF glue (urea resin, melamine urea resin), 9-25%
- Paraffin wax emulsion, 0.5-3%

Coated MDF bonded with PMDI consist of (dimensions as % by mass):

- Wood chips, approx. 90%
- Water, approx. 5-9%
- PMDI glue (polymer 4.4' diphenyl methane diisocyanate), approx. 3.5%
- Paraffin wax emulsion, 0.5-3%

Wood from indigenous, largely regional forest plantations is used for manufacturing MDF. This wood is typically procured from forests within a radius of up to 250 km of the plants' locations (maximum distances for wood procurement in extreme cases can reach 600 to 850 km, depending on the site).

Furthermore, sawmill residues are also used as raw materials in the production of MDF.

The entire particleboard range can be made available on request as FSC® certified or PEFC™ certified products.
Additionally, all range includes CE marked products.

2.7 Manufacture

The manufacturing of MDF comprises the following steps:

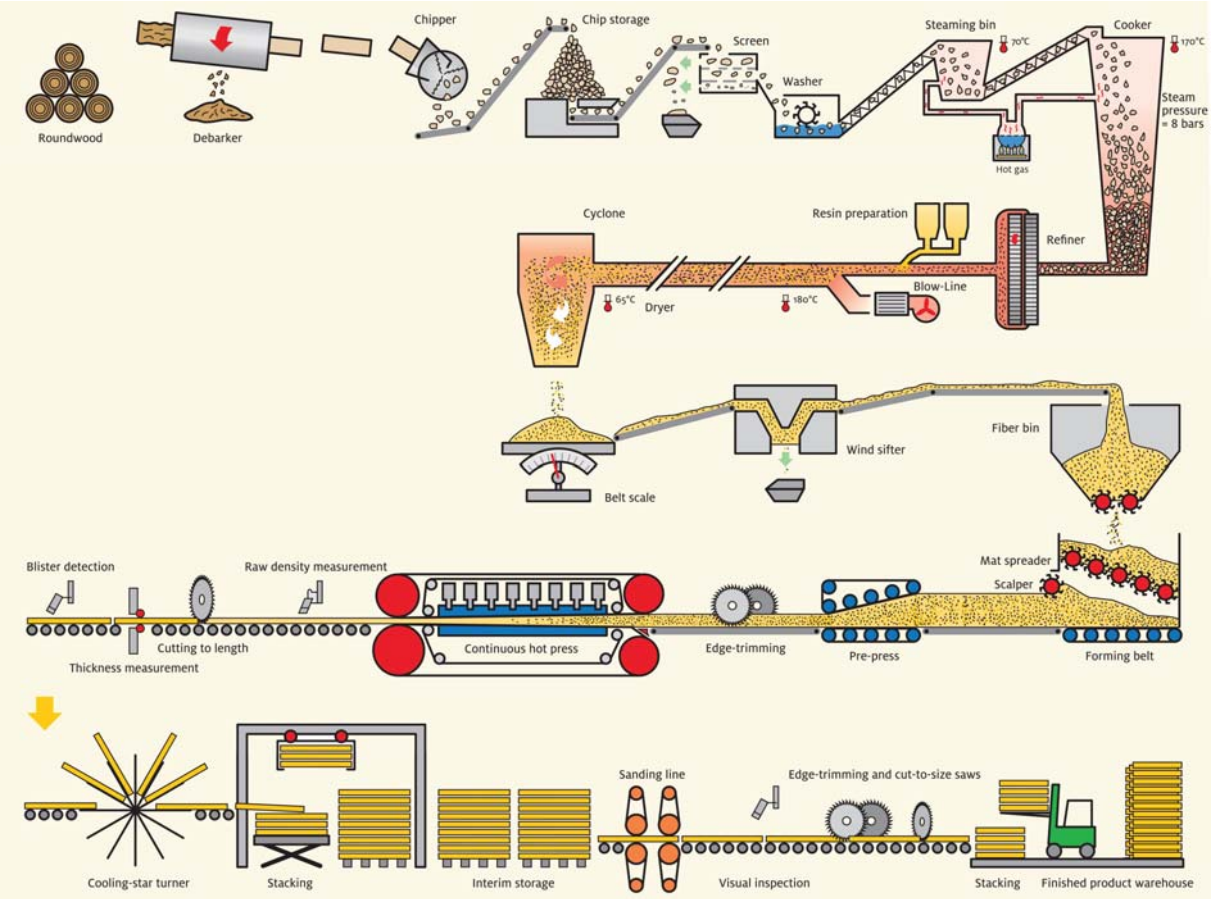
1. Debarking the logs
2. Chipping the wood to chips of approx. 3 x 3 cm in size
3. Boiling the chips
4. Defibring in the refiner
5. Gluing the fibres with synthetic resin
6. Drying the fibres to a residual moisture content
7. Scattering the glued fibre on a forming belt
8. Pressing the fibre mat in a continuous hot press under high pressure
9. Cutting the continuous mat into raw board formats
10. Cooling the raw boards in star coolers
11. Stacking
12. Sanding the top or underside after the air-conditioning phase

All leftovers incurred during board manufacture are redirected to be used as fuel to supply the energy needs of the manufacturing process on site.

A process diagram is presented below.

The production sites are certified according to the following standards:

- /ISO 9001:2008/;
- /ISO 14001:2009/;
- /OHSAS 18001:2007/;
- /EN ISO 50001:2011/ (German and Portuguese sites).



2.8 Environment and health during manufacturing

Health protection: Due to the manufacturing conditions, no special health protection measures over and beyond the regulatory guidelines are required. The reference occupational exposure limit values are complied with.

Emissions into air: Waste air generated during production is cleaned in accordance with regulatory requirements. Emissions have to comply with the values specified by the operation licenses of the different sites, specified according to national laws.

Emissions into water/soil: No normal process contamination of water or soil exists. Waste water generated in the process is treated onsite and/or directed into the municipal sewage system following pre-treatment. Sludges generated within the water treatment can be used in agriculture as a fertiliser.

Noise: Noise surveys are required and are performed for each site according to respective national regulations. Noise-intensive plant areas such as chipping are encapsulated or protected appropriately by structural measures.
Whenever necessary (close to non-encapsulated areas), the use of ear protection is required (PPE, Personal Protective Equipment) within Sonae Arauco sites, as an additional safety measure.

As mentioned in Clause 2.7, the production sites are all /ISO 14001:2009/ certified.

2.9 Product processing/Installation

Sonae Arauco MDF can be sawn, milled, planed, sanded and drilled using standard machinery or (electric) power tools. Carbide-tipped tools should be given preference, especially on circular saws. Respiratory protection should be worn when using hand-held equipment without suction devices.

Please refer to the respective data sheets for further processing recommendations.

2.10 Packaging

Sonae Arauco MDF is supplied on squared timber bound by plastic or metal bands and covered with corrugated cardboard and, on the bottom, with a cover board.

MDF and steel or PET packing bands for transport packaging can be sorted and directed to the recycling circuits. If re-use or recycling is impractical, the packaging should not be landfilled, but rather directed towards energy recovery.

2.11 Condition of use

The components making up coated MDF correspond with the base material compositions as outlined in Clause 2.6. During hot pressing, the binding agent is linked irreversibly by means of poly-condensation and firmly bonded with the wood. The binding agents are chemically and stably bound to the wood.

VOC emissions: Sonae Arauco MDF is labelled as class A+ according to the French regulation on the labelling of emissions of volatile pollutants from construction and decoration products (with reference to the wall scenario, as a worst case).

Sonae Arauco MDF, coated with melamine impregnated paper at an average area weight of 12.0 kg/m^2 stores 17.5 kg CO_2 equivalent over their service life.

2.12 Environment and health during use

Environmental protection: According to current information, water, air and soil are not exposed to any dangers when the respective products outlined above are used as designated.

Health protection: According to current information, no damage to or impairment of health can be anticipated when MDF is used as designated.
With the exception of low volumes of formaldehyde for UF/MUF-bonded MDF, VOC emissions from products are negligible, and are natural wood ingredients.

2.13 Reference service life

Due to the wide range of applications of Sonae Arauco MDF, no reference service life is declared.

2.14 Extraordinary effects

Fire

Fire retardant classification of particleboard is done according to /EN 13986/. Fire retardant classes are defined in accordance with /EN 13501-1/.

The fire classification of MDF with a raw density of ≥ 600 kg/m³ and a thickness ≥ 9 mm is D-s2, d0. The boards with lower density or thickness are in class E.

Fire retardant boards are classified as B-s1, d0 and B-s2, d0.

Fire safety (for standard MDF boards)

Name	Value
Building material class	D/E
Smoke gas development	S2
Burning droplets	d0

Water

No ingredients are washed out which could be hazardous to water. MDF is not resistant to permanent exposure to water.

Mechanical destruction

Mechanical destruction of MDF boards can result in sharp edges on the broken panel edges (risk of injury).

2.15 Re-use phase

Recycling: Sonae Arauco MDF from construction can be collected separately and utilised in the manufacture of particleboard. This is based on the condition that the wooden boards are not fully glued.

Energy recovery: Due to the high heating value of approx. 17.0 MJ/kg at 20 % moisture content assumed for post-consumer boards, MDF can be used for energy recovery and the generation of heat and electricity (e.g. in CHP plants), following the cascading principle for wood.

2.16 Disposal

Sonae Arauco MDF leftovers and residual materials incurred as a result of demolition measures on the building sites should be primarily directed towards material recycling. If this is not possible, they must be directed toward energy recovery instead of landfilling.

Waste code according to the /European List of Waste/: 17 02 01

2.17 Further information

Further information such as technical datasheets, etc. can be downloaded under:

www.sonaearauco.com

3. LCA: Calculation rules

3.1 Declared Unit

The declared unit for the LCA is 1 m^2 of average Sonae Aracuo medium density fibreboard (MDF), coated with melamine impregnated paper.
The weighted average was calculated based on production volumes from representative plants in all countries where Sonae Arauco was operating in 2012.

Information on the declared unit

Name	Value	Unit
Declared unit	1	m^2
Conversion factor to 1 kg	0.08333	-
Mass reference	12	kg/m²

3.2 System boundary

Type of the EPD: cradle-to-gate - with options

Modules A1 – A3 of the production stage cover the manufacturing of the products, including raw material extraction and processing, energy generation, the production of ancillary products and packaging materials, transport, as well as all waste treatment processes. Eventual benefits of recycling or energy recovery are neglected.
The resource aspects of wood were inventoried via material inherent properties as resource extraction of CO_2 from the atmosphere and the lower heating value as the use of renewable energy. Material inherent properties are subject to co-product allocation as ruled in /EN 15804/.
For the input of post-consumer wood, the carbon stored in wood is inventoried as material inherent property as negative input of stored carbon, expressed in CO_2-equivalent, whereas the energy content of wood is inventoried as input of renewable secondary material/fuel (as applicable).
The use of secondary wood as a material or fuel input to the product system is inventoried from the end-of-waste state of the recycled wood onward.

Module A5 covers the transport of the packaging material from the construction site and its disposal. Default end-of-waste states for the packaging materials from the packed products at the construction site are defined in analogy for wastes occurring in modules A1-A3. Eventual further inputs for the installation of the products are not considered due to the broad applicability of the assessed products.
The substituted primary material from the net amount of recycled material and from recovered energy exported from the product system in Module A5 are declared in Module D.

Module C3 covers the preparation of the post-consumer board to become a secondary fuel: the end-of-waste status for recycled wood-based boards is defined as the point where they have been sorted and chipped, ready to be used as secondary fuels.
In line with /EN 16485/, the export of the biogenic carbon stored in the board, expressed in CO_2-equivalent is also reported in module C3.

Module D compiles all the benefits and burdens associated with the secondary fuels, secondary materials and exported energy leaving the production system in the modules A5 and C3.
Therefore, module D covers the avoided burdens from recycling and from energy recovered from the waste treatment in module A5 as well as the transport of the obsolete boards to a biomass combustion plant, the combustion process itself and the loads and benefits of the substitution of fossil fuels and/or electricity.
Substitution effects in module D are always calculated for the net amount of secondary material or secondary fuel of the product system in line with /EN 16485/.

3.3 Estimates and assumptions

For the quantification of the net flows of recycled wood (input of post-consumer wood used as a fuel minus post-consumer wood exiting the product system into module D for energy recovery), it was assumed that all inputs of post-consumer wood are used as a fuel; inputs of post-consumer wood beyond the need of wood fuel used in production was considered to be used as a recycled material input. Beyond that, no relevant estimates or assumptions had to be made beyond the information provided in this EPD.

3.4 Cut-off criteria

The applicable criteria for the exclusion of inputs and outputs are defined in /EN 15804/, clause 6.3.5, and in the /IBU PCR part A/ (IBU 2013), respectively.
All data were taken into account that resulted from the data collection procedure in the plants, e.g. related to fuels, raw material input, use of ancillary materials, waste flows, emissions into air, water use, waste water, transport means and transport distances, etc..
Expenses for the general management, research & development, administration and marketing – if known – were not taken into account.
The production of eventual packaging of ancillary material or other inputs used during production (and some of the reported wastes) were generally neglected; in most cases reusable bins or containers are used. In addition, the amounts of reported (unspecific) wastes are that small that their production can be considered not relevant for the life cycle assessment. Additional plant specific information can be found in the respective chapters for each plant.
Beyond that some plants reported ancillary materials that were cut off due to very small amounts and as inputs not directly related to production processes but to the maintenance of infrastructure, e.g. acetylene and oxygen for soldering, etc.
With this approach also mass and energy flows below 1 percent of total mass and energy flows caused by the declared products were included in the assessment.
Beyond that, no material or energy flows were neglected that would have been known by the persons re-sponsible for the project and that could have been expected to contribute significantly to the environmental indicators declared. It can thus be assumed that the total contribution of the neglected processes is not higher than 5 % of the declared impact categories.

3.5 Background data

Datasets from /ecoinvent v.2.2/ including all updates available under www.lc-inventories.ch were used as

background data exclusively; these updates include the update of energy mixes and some process chains, e.g. for the provision of natural gas. Therefore, the latest update of the background data took place in 2014.

3.6 Data quality

The requirements on the data quality and the background data correspond to the provisions in /EN 15804/ and the /IBU PCR part A/ (IBU 2013) respectively:

- Data are as current as possible. Datasets used for calculations were updated within the last 10 years for generic data and within the last 5 years for producer specific data;
- Datasets are based on 1-year averaged data as a general rule;
- The time period over which inputs to and outputs from the system are accounted for is 100 years from the year for which the data set is deemed representative;
- The technological coverage reflects the physical reality for the declared products;
- The background datasets comply with the quality guidelines of /ecoinvent 2.2/; deviations from the methodological prescriptions of /EN 15804/ and the /IBU PCR part A/ (IBU 2013) respectively are possible but acceptable according to /IBU PCR part A/ (IBU 2013).

3.7 Period under review

The company data gathered for this EPD represents the year 2012.

3.8 Allocation

The inventories for the wood inputs were taken from /ecoinvent 2.2/. In ecoinvent, the forestry and sawmilling processes are allocated based on revenues of the different co-products of a joint co-production process /Werner et al., 2007, based on Schweinle, 2000/. In these datasets, resource corrections are made for incorporated biogenic carbon and renewable energy; these flows thus reflect the real physical flows.
In the case of sites where several products were produced and no product specific information was available, all inputs and outputs related to production processes where attributed based on total mass of production; packaging material was attributed based on total volume of the production. Inputs and outputs for coating processes that could not be separated from the data on plant level were conservatively attributed to the particleboard production.
Post-consumer secondary wood is used as a fuel input to produce MDF; for this input as well as for the end-of-life scenario, the end-of-waste status was defined after the sorting and chipping of the wood-based board in line with /EN 16485/ (see also section 3.2).
In analogy, MDF leaving the product system in the end-of-life is considered a secondary fuel; its combustion and the benefits of energy recovery are declared in module D.
Waste packaging in module A5 was considered not to reach the end-of-waste state as a fuel. Its incineration is reported in A5, the benefits of energy recovery in module D. The benefits of the recycling of minor amounts of packaging materials are disregarded.
Biogenic carbon and primary energy content are considered material inherent properties and "imported" and "exported" to/from the system in line with the mass flows of wood.
No co-product allocation was made in the modelling of the life cycle assessment underlying this EPD.

3.9 Comparability

Basically, a comparison or an evaluation of EPD data is only possible if all the data sets to be compared were created according to /EN 15804/ and the building context, respectively the product-specific characteristics of performance, are taken into account.

4. LCA: Scenarios and additional technical information

The following technical information is a basis for the declared modules or can be used for developing specific scenarios in the context of a building assessment if modules are not declared (MND).

Installation (A5)
Eventual further inputs for the installation of the products are not considered due to the broad applicability of the assessed products.
An average transport distance of 30 km was assumed for packaging waste from the construction site to the recycling plant or to the municipal waste incineration plant. The municipal waste incineration plant is assumed to have an overall energy efficiency of 53 % related to the lower heating value of the waste input; 92 % of the recovered energy is heat, 8 % is electricity (according to specifications of MWI plants in /ecoinvent 2.2/).

Waste treatment (C3)
13.7 kg of coated MDF are chipped, of which 12.1 kg are exported as net flows from the product life cycle into module D, assuming a moisture content of 20 %.

Reuse, recycling, recovery potential (D)
According to default assumptions in other IBU EPDs, post-consumer wood is used as a secondary fuel for energy recovery in a biomass combustion plant with an over-all energy efficiency of 93 % related to the lower heating value of the fuel input; 91 % of the recovered energy is heat, 9 % is electricity.

5. LCA: Results

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LCA; MND = MODULE NOT DECLARED)

PRODUCT STAGE			CONSTRUCTION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARIES
Raw material supply	Transport	Manufacturing	Transport from the gate to the site	Assembly	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	MND	X	MND	MND	MNR	MNR	MNR	MND	MND	MND	MND	X	MND	X

RESULTS OF THE LCA - ENVIRONMENTAL IMPACT: Medium density fibreboard (MDF), coated with melamine impregnated paper, per m²

Parameter	Unit	A1-A3	A5	C3	D
Global warming potential	[kg CO_2-Eq.]	-2.96	0.94	17.64	-9.74
Depletion potential of the stratospheric ozone layer	[kg CFC11-Eq.]	8.27E-7	1.04E-9	5.55E-9	-1.13E-6
Acidification potential of land and water	[kg SO_2-Eq.]	6.06E-2	1.95E-4	5.16E-4	-1.01E-2
Eutrophication potential	[kg $(PO_4)^{3-}$-Eq.]	9.98E-3	4.56E-5	6.76E-5	-1.04E-3
Formation potential of tropospheric ozone photochemical oxidants	[kg ethene-Eq.]	4.08E-3	7.71E-6	2.33E-5	-9.56E-4
Abiotic depletion potential for non-fossil resources	[kg Sb-Eq.]	5.24E-5	2.66E-8	7.94E-8	-1.11E-6
Abiotic depletion potential for fossil resources	[MJ]	269.88	0.34	2.26	-200.98

RESULTS OF THE LCA - RESOURCE USE: Medium density fibreboard (MDF), coated with melamine impregnated paper, per m²

Parameter	Unit	A1-A3	A5	C3	D
Renewable primary energy as energy carrier	[MJ]	82.28	0.00	0.28	-4.62
Renewable primary energy resources as material utilization	[MJ]	190.87	0.00	0.00	0.00
Total use of renewable primary energy resources	[MJ]	273.15	0.00	0.28	-4.62
Non-renewable primary energy as energy carrier	[MJ]	232.25	0.36	2.62	-195.85
Non-renewable primary energy as material utilization	[MJ]	39.88	0.00	0.00	0.00
Total use of non-renewable primary energy resources	[MJ]	272.13	0.36	2.62	-195.85
Use of secondary material	[kg]	0.37	0.00	0.00	0.00
Use of renewable secondary fuels	[MJ]	18.20	0.00	0.00	153.26
Use of non-renewable secondary fuels	[MJ]	0.00	0.00	0.00	33.61
Use of net fresh water	[m^3]	0.27	0.00	0.00	-0.06

RESULTS OF THE LCA – OUTPUT FLOWS AND WASTE CATEGORIES: Medium density fibreboard (MDF), coated with melamine impregnated paper, per m²

Parameter	Unit	A1-A3	A5	C3	D
Hazardous waste disposed	[kg]	2.31E-4	1.80E-7	3.05E-6	-6.94E-5
Non-hazardous waste disposed	[kg]	0.96	0.01	0.01	0.09
Radioactive waste disposed	[kg]	5.38E-4	2.72E-7	2.28E-5	-3.66E-4
Components for re-use	[kg]	0.00	0.00	0.00	0.00
Materials for recycling	[kg]	0.07	0.03	0.00	0.00
Materials for energy recovery	[kg]	0.00	0.00	13.70	0.00
Exported electrical energy	[MJ]	0.00	3.85	0.00	0.00
Exported thermal energy	[MJ]	0.04	0.33	0.00	0.00

6. LCA: Interpretation

Figure 1 illustrates the contribution of each life cycle stage to the overall indicator results of the impact assessment (impact from module A1-A3 = 100 %) for MDF coated with melamine-impregnated paper. The Figure illustrates that for the *abiotic depletion potential for fossil resources (**ADP fossil**)*, the benefits from the energy recovery of coated MDF are higher than the impacts during the life cycle, notably the impacts from production. For other impact categories, the benefits of energy recovery lie between 2 % to 75 %, depending on the impact category under consideration.

The *global warming potential (**GWP**)* is an indicator for the contribution to climate change and is quan-tified based on the emissions of gases that absorb radiative forcing.

The production of the UF/MUF resins contributes about 35 % to the **GWP** (excluding biogenic carbon) caused during production of uncoated MDF. Further contributions stem from the production of heat from light fuel oil and natural gas (about 30 %) and from the generation of electricity (about 20 %). Transport of raw materials are responsible for about 5% of the **GWP**.

For MDF coated with melamine impregnated paper, 70 % of the **GWP** are caused during the board production, 30 % are associated with the production of the melamine impregnated paper.

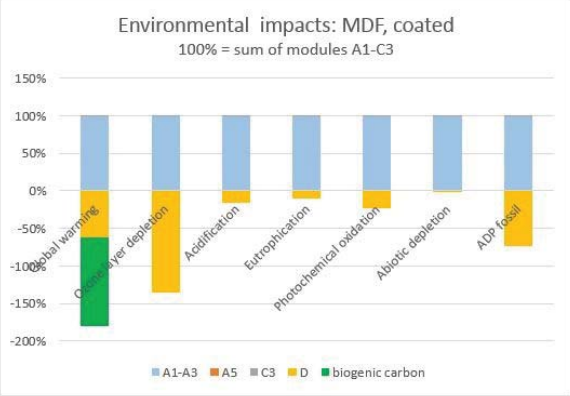


Figure 1: Environmental impacts of MDF coated with melamine impregnated paper along its life cycle (impacts from production modules A1-A3 = 100 %; for illustrative purposes, the biogenic carbon included in the GWP is documented separately)

Figure 2 illustrates that the biogenic carbon stored in the MDF coated with melamine impregnated paper, expressed as CO_2-equivalent, is higher than the CO_2 emissions from fossil sources, leading to a negative **GWP** for the production module A1-A3. The potential substitution effect in module D partly offsets the GHG emissions during the production phase (module A1-A3).

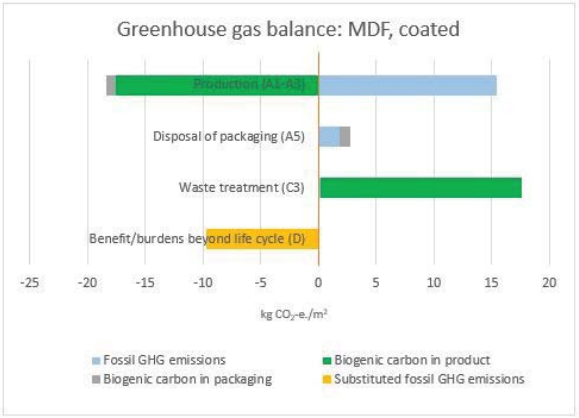


Figure 2: Carbon footprint of MDF, coated with melamine impregnated paper

The **GWP** is dominated by CO_2 emissions and removals.

The *ozone layer depletion potential (**ODP**)* is quantified based on the emissions of gases that can destroy stratospheric ozone.
The **ODP** is caused mainly by emissions of Halon 1211, which are associated with the production and transport of natural gas. For uncoated MDF, around 60 % of the **ODP** are associated with the use of natural gas in upstream processes for the production of UF/MUF resins.
For MDF coated with melamine impregnated paper, 63 % of the **ODP** are caused during the board production, 34 % are associated with the production of the melamine impregnated paper.

The *acidification potential (**AP**)* is created with the transformation of airborne emissions into acids, which among other can reduce soil fertility.
Roughly 35 % of the **AP** are caused by the upstream processes for the production of UF/MUF resins used in the production of the uncoated MDF. Electricity generation is responsible for about 20 % of the **AP**, the transport of raw materials for about 6 %. About 30 % are caused by the on-site combustion processes for the production of heat and, in some plants, for the generation of electricity.
For MDF coated with melamine impregnated paper, 75 % of the **AP** are caused during the board production, 20% are associated with the production of the melamine impregnated paper.
The **AP** is caused in comparable shares by emissions of ammonia, nitrogen oxides and sulphur dioxide.

The *eutrophication potential (**EP**)* quantifies the accumulation of nutrients in soils and watersheds, which can cause increased growth of algae and shifts in species composition.
The **EP** of the uncoated MDF is caused by upstream processes for the production of UF/MUF resins (about 40 %), on-site combustion processes (about 20 %) and by the transport of raw materials (about 18 %); electricity generation is responsible for another 15% of the **EP**.
For MDF coated with melamine impregnated paper, 74 % of the **EP** are caused during the board production, 23 % are associated with the production of the melamine impregnated paper.
The **EP** is caused mainly by airborne emissions of ammonia and nitrogen oxides as well as phosphate/phosphorus emissions into the groundwater.

The *photochemical oxidation potential (**POCP**)* assesses the contribution of airborne emissions that contribute to summer ozone creation.
For uncoated MDF, the upstream processes of production of UF and MUF resins cause 40 % of the **POCP**; another 35 % of the **POCP** are associated with on-site emissions from combustion processes (CO, SO_2) and from the gluing system (formaldehyde).
For MDF coated with melamine impregnated paper, 77 % of the **POCP** are caused during the board production, 20 % are associated with the production of the melamine impregnated paper.

The *abiotic resource depletion potential of fossil resources (**ADP fossil**)* assesses the use of scarce fossil resources such a natural gas or crude oil.
The **ADP** (fossil resources) is caused mainly by the consumption of natural gas and crude oil for the production of the UF/MUF resins and – to a much smaller extend – for the generation of electricity.

The *abiotic resource depletion potential for mineral resource (**ADP elements**)* assesses the use of scarce mineral resources such as ores and other mineral raw materials.
The **ADP** (elements) is caused almost completely by infrastructure processes, such as the buildings required for the production of UF/MUF resins (about 80 %); the main resources contributing to the **ADP** (elements) are gold and copper.

The main use of *renewable primary energy (**PERE**)* is the heating value of the wood in MDF; this amount of non-used renewable energy is exported in module C3

and used energetically as a renewable secondary fuel in module D. The renewable primary energy used as energy is mainly woody biomass.

The major share of the *non-renewable primary energy (**PENRE**)* is used energetically, mainly as natural gas in the upstream process for the production of the components of the gluing system and for the production of the melamine of the impregnated paper. A minor share is used as a material, i.e. as components of the gluing systems and of the melamine impregnated paper; this non-renewable primary energy used as a material is not used within the life cycle of MDF; it is exported in module C3 and used energetically as a non-renewable secondary fuel in module D.

The indicator values for *wastes* refer to the amount of wastes that is landfilled after an eventual pre-treatment of the wastes.

The main part of the wastes associated with the production of MDF is non-hazardous waste, mainly resulting from the disposal of infrastructure associated with e.g. production halls or roads.
Hazardous wastes are generated throughout the production chain, e.g. related to disposal of ashes, production wastes from chemical industry or from the production of primary aluminium for infrastructure processes.
The generation of radioactive waste is associated with the production of nuclear power.

The *net consumption of fresh water* is caused mainly by cooling processes throughout the production chain as well as partly for the generation of electricity.

The *further indicators on environmental aspects* are singular values that result from the inventorying of waste streams into thermal waste treatment, energy recovery and recycling.

7. Requisite evidence

7.1 Formaldehyde

For UF/MUF bonded boards:
(tests made on raw boards)

Measuring agency: Eurofins Denmark & WKI & LQAI Porto
Test report, date: G15360 & G15359 & G15810 & MAIC-2012-1498 & LQAI.MC.52/12, dated 13-06-2012 & 13-06-2012 & 29-06-2012 & 15-05-2012 & 26-07-2012
Result: Formaldehyde emissions tests were performed for uncoated MDF (F-4star class and CARB 2 class) according to /ISO16000-11/, with the wall panel loading scenario.
The measured formaldehyde emissions ranged between lower than 60 mg/m^3, resulting in a classification A, and above 120 mg/m^3, resulting in a classification C.

7.2. MDI

For PMDI bonded boards:
(tests made on raw boards)

Measuring agency: Eurofins Denmark
Test report, date: G14684 & G16845, dated 10-05-2012 & 04-10-2012
Result: Formaldehyde emissions tests were performed for uncoated MDF (using PMDI resin) according to /ISO16000-11/, with the wall panel loading scenario.
The measured formaldehyde emissions were lower than 10 mg/m^3, resulting in a classification A+.

7.3 Checking for the pretreatment of the substances used

No post-consumer wood is used in the production of Sonae Arauco MDF.

7.4 VOC emissions

(tests made on raw boards)

Measuring agency: Eurofins Denmark & WKI & LQAI Porto
Test report, date: G15360 & G15359 & G15810 & MAIC-2012-1498 & LQAI.MC.52/12, dated 13-06-2012 & 13-06-2012 & 29-06-2012 & 15-05-2012 & 26-07-2012
Result: VOC emissions tests were performed for particleboards (F-4star class and CARB 2 class) according to /ISO16000-11/, with the wall panel loading scenario.
The VOC measurements allowed for a classification A, when excluding formaldehyde (emissions ranged between lower than 60 mg/m^3, resulting in a classification A, and above 120 mg/m^3, resulting in a classification C, when taking formaldehyde emissions into consideration).

Measuring agency: Eurofins Denmark
Test report, date: G14684 & G16845, dated 10-05-2012 & 04-10-2012
Result: VOC emissions tests were performed for uncoated MDF (using PMDI resin) according to /ISO16000-11/, with the wall panel loading scenario.
The VOC measurements allowed for a classification A+.

7.5 PCP/Lindane

(tests made on raw boards)

Measuring agency: MPA Eberswalde, Materialprüfanstalt Brandenburg GmbH, Germany & EPH, Dresden, Germany
Test report, date: MPA: 31/14/7835/01, dated 28-05-2014 & EPH: CT-14-12-22-07, dated 22-12-2014
Result: According to /EN 622-5/ the MDF samples meet the requirements on the limit value for the

content of PCP (5 mg/kg according to the German regulation /ChemVerbotsV § 1 (15)/).

There is no obligation for the MDF labelling according to /EN 13986/ regarding the PCP-content.

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