

Life Cycle Analysis Report

GUTEX wood fibre insulation

Summary

Environmental impact study: GUTEX wood fibre insulation.

The analysis was done as part of the TKI project 'Biobased in NMD' to gain insight into the environmental impact of the product mentioned and for inclusion in the National Environmental Database, commissioned by GUTEX.

This analysis was carried out by Agrodome B.V.

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Disclaimer

This report can only be used as a whole, if part of the information is used, the user must refer to the entire report. The report is the property of the manufacturer and may not be used by third parties without the written consent of the manufacturer.

The information contained in this document is provided under the responsibility of GUTEX according to the EN15804+A2:2019 and the 'Bepalingsmethode Milieuprestatie Bouwwerken - Stichting NMD'. The NMD bepalingsmethode is the reference for the Products Categories Rules (PCR).

Comparisons based on the information from this report are only possible and valid if the starting points of the calculations and data collection are the same and if it concerns the same applications.

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Introduction

This document contains the Life Cycle Impact Assessment (LCIA) and serves as a background report for the Environmental Product declaration (EPD) for Gutex wood fibre insulation. This report has been drawn up in accordance with EN 15804 +A2 and the NMD Bepalingsmethode 'Milieuprestatie Bouwwerken', version 1.1 March 2022 (www.milieudatabase.nl). The NMD Bepalingsmethode is used as Product Category Rule (PCR) for all construction products.

An LCA is a clearly defined method to analyse the environmental impact of a product or element. An LCA quantifies the potential environmental impacts of a product or element throughout its life phase, from the extraction of the raw materials, production, use and final stages, including waste treatment, recycling and/or reuse.

This report contains the 4 phases of the LCA (goal and scope, life cycle inventory (LCI), assessment of the environmental impact of the life cycle (LCIA) and its interpretation). The different chapters describe these per phase of the life cycle of the products. The topics mentioned in the ISO guidelines (ISO 14040 and 14044) have been investigated and elaborated in this report.

Goal and target audience of this research

Goal

The aim of the research is to collect accurate and reliable information on the environmental effects over the lifetime of the product.

This LCA study is carried out within the TKI project 'Biobased in NMD'. The project creates Category 1-product cards for a range of biobased building materials for the National Environmental Database (Nationale Milieudatabase, NMD). Also, within the project methods are developed for valuating biogenic carbon storage in biobased building materials, and scenarios other than the standard end-of-life scenarios, in particular opportunities for reuse and recycle.

The scope of the LCA study for GUTEX wood fibre insulation is 'Cradle to Grave'. Furthermore, Gutex wants to gain insight in the environmental impact of the product for the Dutch market. Based on this information, the client can, if desired, make improvements in the production and processes of the products mentioned. This report will provide sensitive details regarding used calculation methods and assumptions. The Environmental Product Declaration (EPD) based upon this background report can be used for building or building part level assessments by designers, architects, constructors, developers etc. The EPD is made for business-to-business communication. The EPD will also be published in the National Environmental Database (NMD) as a Category-1 product, verified data from companies.

Target audience

The target group is, in addition to the client, GUTEX Holzfaserplattenwerk, their Dutch customers and the group of users of the National Environmental Database (NMD). They can use the information on the products in the NMD in calculations and comparisons. Also, the results can be used to inform customers on the environmental impact of the product.

The content of the report can be used for inclusion in environmental databases. Due to the sensitive content, this background report is drafted for internal use only. The exported EPDs will be available for distribution on the market.

Parts of the study

In accordance with the NMD Bepalingsmethode 'Milieuprestatie Bouwwerken' version 1.1, the following topics have been examined and elaborated in this report:

- Description of the products
- Function of the products
- Functional units
- System boundaries
- Allocation procedures
- Impact categories and assessment method
- Data requirements
- Data quality
- Assumptions and limitations
- Critical consideration of the results

Life Cycle Inventarisation (LCI)

Product Description

GUTEX wood fibre insulating boards are board-shaped insulating materials manufactured from wood fibres in accordance with EN 13171.

By adding low quantities of polyurethane (PUR) resin, insulating boards are manufactured from wood fibres in a dry process. After production, they are cut and profiled and finished where necessary. Water-repellent and non-water-repellent single-layer insulation panels can be manufactured to a thickness of 240 mm.

In this study, two different product groups were assessed:

- GUTEX wood fibre insulation with wax, for outdoor application (Ultratherm, Multiplex-top, Multitherm, Thermoflat, Thermowall (normal, +gf, +NF, +L))
- GUTEX wood fibre insulation indoors (without wax) (Thermosafe (homogen + wd), Thermoinstal, Thermoroom)

Function of the product

GUTEX wood fibre insulating can be used in both old and new buildings: as a thermal insulation composite system for the plaster facade, wall insulation for back-ventilated facades, on-roof and/or false ceilings, insulating ceilings between floors, interior insulation of external walls, insulation of installation levels and impact sound insulation for floors.

Functional unit

One square meter of wood fibre insulation, with a lifespan of 75 years, with an insulation value of 3,5 m²k/W and a thickness and density in the table below.

Name	Product	Value	Unit
Thickness	wax	140	mm
	indoors	140	mm

Density	wax	167,12	kg/m ³
	indoors	165,53	kg/m ³
Weight	wax	23,4	kg/FU
	indoors	23,2	kg/FU

Reference Service Life

The lifespan of the product, as declared by the manufacturer, is 75 years when correctly applied as an insulation material. No maintenance is needed.

System boundaries

The LCA study was created for 'Cradle to Grave A1-D' according to the modules below. All declared values relate to the specified functional unit. The functional unit of the European standard EN 15804 +A2 and the NMD - Bepalingsmethode 'Milieuprestatie Bouwwerken' are identical.

The environmental performance of building materials is categorized in four modules corresponding to different lifecycle phases in the building material; Modules A (production of materials and construction), B (use phase), C (end-of-life phase of the building) and D (loads and benefits outside the system boundary); see Figure 1.

Product stage			Construction installation		Use stage							End of life stage				Beyond the system
Raw materials	Transport	Manufacturing	Transport	Construction installation stage	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
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Figure 1: Calculated modules GUTEX wood fibre insulation

For this LCA study, all modules A1-3, A4, A5, B, C and D have been examined, except B6 and B7.

Allocations

There are no allocations of co-products from the wood fibre insulation.

Collection of process and product data

For the collection of the process and product data, information is used provided by the manufacturer, GUTEX Holzfaserplattenwerk.

For this LCA analysis the figures from an LCA study performed in Germany by Sphera Solutions are used for the wood fibre boards. This study was completed in 2020. These data were discussed and checked with GUTEX in 2022 and are completely up-to-date.

Since not all used materials are present in the database with the exact brand name, for those materials a choice was made from the available data in the Ecoinvent database, version 3.6, and the NMD database version 3.6, based on the main ingredients.

For the modelling of the transport, we opted for default and deviated from it where necessary with substantiation from the producer.

All operating data and inputs are taken into consideration in the analysis.

Methodology LCA and calculation methods

The LCA has been carried out in accordance with the NMD Bepalingsmethode 'Milieuprestatie Bouwwerken' 1.1, March 2022, taking into account the standards from the ISO 14000 series: 14025, 14040 and 14044.

When calculating the environmental impact categories, Simapro, version 9.4.0.2 and environmental data from the NMD basic processes database, version 3.6 release date October 2022, where no NMD data were available the Ecoinvent database, version 3.6, was used.

Data quality

Unit processes		
COMPLETENESS		SCORE ¹
Completeness of environmental interventions	All environmental interventions have a value	1
Completeness of economic flows	All flows are qualified and quantified	1
Mass balance at process level	Closure >95%	1
Mass balance at company level	Closure >95%	1
Energy balance at company level	Closure >95%	1
REPRESENTATIVENESS		
Time-bound representativeness of process in relation to year of assessment	The information used in this LCA of the production process of the products is based on measurements and observations from 2019 (energy, waste percentages, quantities net per element, production volume). All data have been checked for topicality with the client.	3
Geographical representativeness	The most important raw material, wood fibres, is coming from sustainable managed forest in Germany (Black Forest).	1
Technological representativeness	The company, process and product data come from GUTEX	1
CONSISTENTIE EN REPRODUCEERBAARHEID		
Uniformity and consistency	All data are checked on uniformity and consistency	1
Reproducibility by third parties	All sources and data are documented. The ownership of the process is a protected process.	5

Table 1: Scores data kwaliteit

¹ Pedigreescore NMD toetsingsprotocol/version 1.0 annex D

Assumptions, omissions and deviations

It is assumed that no maintenance is needed when installed in the building.

No other significant assumptions, omissions or deviations were included in this LCA study.

Additional information

Environment and health during use phase

GUTEX wood fibre insulation does not contain concentrations of substances or materials listed in the “Candidate List of Substances of Very High Concern for authorisation”.

Environmental certificates

GUTEX wood fibre insulation has the natureplus seal of approval, license number: **0104-0604-012-2**.

Biogenic carbon storage

Biogenic carbon storage during the lifetime of the products made from GUTEX wood fibre insulation:
Wax, 260,12 kg Co₂ eq./m³ this makes 70,94 kg C/m³
Indoor, 260,36 kg CO₂ eq./m³ this makes 71,01 kg C/m³.

Other technical information

Composition of GUTEX wood fibre insulation

Material	Share	
	wax	indoor
Wood chips from coniferous wood: fir/spruce	95 %	96%
PUR resin	4 %	4 %
Paraffin wax	1 %	–

Table 2 Composition GUTEX wood fibre insulation

Technical data GUTEX wood fibre insulation

Name	Value	
	wax	indoor
Thickness element at R = 3,5 m ² k/W	140 mm	140 mm
Weight GUTEX wood fibre insulation	23,4 kg/m ²	23,2 kg/m ²
Density	167 kg/m ³	167 kg/m ³
Thermal conductivity λ	0,040 W/mK	0,040 W/mK
Vapour diffusion resistance factor μ	3	3
Specific heat capacity c	2100 J/kgK	2100 J/kgK
Fire resistance class according to EN 13501-1	E	E

Table 3 Technical data GUTEX wood fibre insulation

Scaling

GUTEX wood fibre insulation can basically be produced in many thicknesses. Broadly speaking:

- Proportionally scalable: the product is manufactured with the same composition independently of size
- Reference dimension is 1000 x 1000 x 140 mm, according to GUTEX
- Smallest available size: 135 x 57,5 mm
- Largest available size: 176 x 60 mm.
- Thickness varies between: 20 mm and 160 mm

Production process and Flowchart GUTEX wood fibre insulation

The next page shows the flowchart of the production process of GUTEX wood fibre insulation. This flowchart lists the entire production process starting with the wood chips arriving at the factory.

All input and output flows are being investigated. The mass balance is zero.


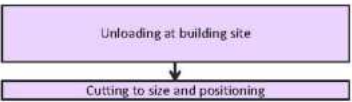
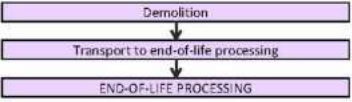
QUANTITY*		INPUT		Gutex with wax		OUTPUT		
QUANTITY*	UNIT	MATERIAL	ENERGY	PROCESS	MATERIAL	EMISSIONS	QUANTITY	UNIT
* for 1 FU m ²								
A1 - A3. MANUFACTURING PHASE								
41,19 kg	Wood chips	lorry, diesel				exhaust gases		
0,93 kg	PUR resin (MDI)	fork lift, diesel						
0,22 kg	Paraffin wax		electricity					
1,03 kg	Wooden pallets (single use)						water vapour	18,80 kg
0,06 kg	PE film		electricity, gas					
0,08 kg	Cardboard							
	Paraffin wax		electricity					
	PUR resin		electricity, gas					
			electricity					
			electricity, gas?					
			electricity		polyethylene waste		0,00 kg	
			fork lift, diesel		paper waste		0,01 kg	
					finished product	exhaust gases		
A4. TRANSPORT PHASE								
	finished product	lorry, diesel		Transport to building site	finished product	exhaust gases		
A5. CONSTRUCTION PHASE								
	finished product	electricity for fixing tools			Wooden pallets (single use)		1,03 kg	
		(process unknown)				PE film		0,06 kg
					Cardboard		0,07 kg	
					wood cut-off during cutting to size		0,14 kg	
B1 - B7. USE AND MAINTENANCE PHASE								
	No processes or nihil			Maintenance phase: no processes				
C1 - C4 and D. DISPOSAL PHASE								
	No processes or nihil							
	Default							
						1 m ³ Holzfaserplatte		23,40 kg
MASS BALANCE								
43,51 kg	TOTAL IN			MASS BALANCE		TOTAL OUT	43,51 kg	
				IN -./- OUT IN KG				
							0,00	

Figure 2: Flowchart GUTEX wood fibre insulation with wax


QUANTITY*		UNIT	INPUT		Gutex Indoors		OUTPUT						
		MATERIAL	ENERGY		PROCESS		MATERIAL	EMISSIONS	QUANTITY	UNIT			
* for 1 FU		m ²											
A1 - A3 MANUFACTURING PHASE													
41,19 kg	Wood chips	lorry, diesel						exhaust gases					
0,93 kg	PUR resin (MDI)	fork lift, diesel											
1,03 kg	Wooden pallets (single use)												
0,06 kg	PE film												
0,08 kg	Cardboard												
	PUR resin	electricity											
		electricity, gas										water vapour	18,80 kg
		electricity											
		electricity											
		electricity											
		electricity											
		fork lift, diesel											
							polyethylene waste		0,00 kg				
							paper waste		0,01 kg				
							finished product	exhaust gases					
A4 TRANSPORT PHASE													
	finished product	lorry, diesel	Transport to building site				finished product	exhaust gases					
A5 CONSTRUCTION PHASE													
	finished product	electricity for fixing tools					Wooden pallets (single use)		1,03 kg				
		(process unknown)								PE film		0,06 kg	
						Cardboard		0,07 kg					
						wood cut-off during cutting to size		0,14 kg					
B1 - B7 USE AND MAINTENANCE PHASE													
	No processes or nihil		Maintenance phase: no processes										
C1 - C4 and D DISPOSAL PHASE													
	No processes or nihil												
	Default												
										1 m ³ Holzfaserplatte		23,17 kg	
MASS BALANCE													
43,29 kg	TOTAL IN		MASS BALANCE					TOTAL OUT	43,29 kg				
			IN -/ - OUT IN KG										
										0,00			

Figure 3: Flowchart GUTEX wood fibre insulation without wax

Explanation Flowcharts and Life Cycle per phase

Production phase (A1-3)

The products are made of wood chips, a residual stream from sawmills.

After the wood chips are delivered at the GUTEX factory the chips will be processed in a defibrator to create the fibres for the boards. The next step is to make the fibres water repelling using paraffin. The fibres will be dried in a flow dryer and then glued with a PUR resin. The sticky fibres are scattered on the forming belt to form a mat. Curing the mat in the calibration and hardening unit. Finally dividing up the mat to boards and profiling them.

For transportations a pile of boards is wrapped in cardboard and PE foil.

Materials and products

The following components and associated NMD, Ecoinvent and/or others processes have been used:

GUTEX wood fibre insulation, required materials for 1 kg of product

Material	NMD or Ecoinvent or other data	Product	Amount/kg
Wood chips	Wood chips, wet, measured as dry mass {Europe without Switzerland} market for Cut-off, U	wax	8,80E-01 kg
		indoor	8,89E-01 kg
PUR resin (MDI)	polyurethane adhesive {GLO} market for polyurethane adhesive Cut-off, U	wax	3,97E-02 kg
		indoor	4,01E-02 kg
Paraffin wax	Paraffin {GLO} market for Cut-off, U	wax	9,51E-03 kg
Pallet	EUR-flat pallet {RoW} market for EUR-flat pallet Cut-off, U	wax	5,98E-03 p
		indoor	6,04E-03 p
PE	0012-fab&Polyethen, LDPE, folie (o.b.v. Packaging film, low density polyethylene {GLO} market for Cut-off, U)	wax	2,63E-03 kg
		indoor	2,66E-03 kg
Cardboard	Corrugated board box {RER} market for corrugated board box Cut-off, U	wax	3,35E-03 kg
		indoor	3,38E-03 kg

Table 4: GUTEX wood fibre insulation, required materials for 1 kg product

Transport

The default values from the determination method (zie pages 19 and 20 of the Bepalingsmethode) are chosen for the modelling of transport. Transportation of the woodchips to the manufacturer is included in the chosen process. For the other materials, a distance of 150 km is used.

Material	km	Explanation
GUTEX wood fibre insulation From producer to building site	150	0001-tra&Transport, vrachtwagen (o.b.v. Transport, freight, lorry, unspecified {GLO} market group for transport, freight, lorry, unspecified Cut-off, U)

Table 5 Transport of additional materials to GUTEX Holzfaserplattenwerk

Energy and water consumption

Energy and water consumption of equipment required for the manufacture of the products under investigation is based on consumption figures for 2020. GUTEX is building a new factory which will

operate climate-neutral. The consumption figures for 2020 can therefore be considered a worst case scenario for the coming years. .

For production, GUTEX uses electricity from its own natural gas-fired CHP plant (44%) as well as electricity from hydropower (54%) and photovoltaics (2%).

GUTEX wood fibre insulation, required energy and water production phase for 1 kg of product

Electricity from grid	Electricity, high voltage {DE} electricity production, hydro, run-of-river Cut-off, U	wax	7,05E-01 MJ
		indoor	7,12E-01 MJ
CHP Electricity	Electricity, low voltage {Europe without Switzerland} heat and power co-generation, natural gas, 160kW electrical, lambda=1 Cut-off, U	wax	5,75E-01 MJ
		indoor	5,80E-01
CHP Heat	Heat, central or small-scale, natural gas {Europe without Switzerland} heat and power co-generation, natural gas, 160kW electrical, lambda=1 Cut-off, U	wax	6,21E+00 MJ
		indoor	6,27E+00 MJ
Diesel	Diesel, burned in building machine {GLO} market for Cut-off, U	wax	1,50E-02 MJ
		indoor	1,50E-02 MJ

Table 6: GUTEX wood fibre insulation, required energy and water production phase for 1 kg of product

Outgoing flows

For the outgoing flows, the following waste scenarios were used in accordance with the bepalingsmethode:

GUTEX wood fibre insulation, outgoing flows production phase for 1 kg of product

Material	%	NMD or Ecoinvent or other data	Product	Amount/kg
Cardboard	5	0245-sto&Stort hout, 'schoon' (o.b.v. Waste wood, untreated {Europe without Switzerland} treatment of waste wood, untreated, sanitary landfill Cut-off, U)	wax	2,00E-05
			indoor	2,00E-05
	95	0297-avC&Verbranden organisch afval (4,29 MJ/kg) (o.b.v. Biowaste {GLO} treatment of biowaste, municipal incineration Cut-off, U)	wax	4,00E-04
			indoor	4,00E-04
PE	10	0251-sto&Stort PE (o.b.v. Waste polyethylene {Europe without Switzerland} treatment of waste polyethylene, sanitary landfill Cut-off, U), ook elastomeren als epdm	wax	1,00E-05
			indoor	1,00E-05
	85	0264-avC&Verbranden kunststoffen (28,67 MJ/kg) (o.b.v. o.b.v. mix 21% PE, 21% PP, 20% PVC, 17% PS en 21% mixture)	wax	1,00E-04
			indoor	1,00E-04
	5	0286-reC&verwerking kunststof voor recycling (o.b.v. Waste polyethylene, for recycling, sorted {Europe without Switzerland} market for waste polyethylene, for recycling, sorted Cut-off, U)	wax	1,00E-05
			indoor	1,00E-05

Table 7: GUTEX wood fibre insulation, outgoing flows production phase for 1 kg of product

Benefits and burdens outside the system boundary

Material	Process	Product	Amount/kg
Cardboard	0268-avD&Vermeden energieproductie AVI, o.b.v. HERNIEUWBARE grondstoffen, 18% elektrisch en 31% thermisch (per MJ LHV)	wax	6,00E-03 MJ
		indoors	6,00E-03 MJ
PE	0267-avD&Vermeden energieproductie AVI, o.b.v. FOSSIELE grondstoffen, 18% elektrisch en 31% thermisch (per MJ LHV)	wax	4,00E-03 MJ
		indoors	4,00E-03 MJ
	0278-reD&Module D, PE, per kg NETTO geleverd (o.b.v. vermeden Polyethylene, high density, granulate {RER}) production Cut-off, U en kwaliteitsfactor 0,67)	wax	1,00E-05 kg
		indoors	1,00E-05 kg

Table 8: GUTEX wood fibre insulation, benefits and burdens outside system boundary, production phase, for 1 kg of product

Construction process phase (A4-5)

Transport to the building site (A4)

The finished product is transported from the production site in Germany to the Netherlands. For the transport movement from Germany to the Netherlands, no empty return is applied. The default from the determination method version 1.1 is used for the transport to the building site, in this case Waldshut-Tiengen to Utrecht, the Netherlands.

Material	km	Explanation
GUTEX wood fibre insulation From producer to building site	822	0001-tra&Transport, vrachtwagen (o.b.v. Transport, freight, lorry, unspecified {GLO}) market group for transport, freight, lorry, unspecified Cut-off, U)

Table 9 Transport, from GUTEX Holzfaserplattenwerk to the construction site

Processing and construction on the construction site (A5)

At the construction site the insulation is cut to size and fitted; for this only hand tools are used. The wood fibre cut-offs and packaging materials (cardboard and PE foil) are disposed of together with other building materials. For this, the following waste scenario was taken into account:

Product	%	Process	Product	Amount/kg
Cut-offs	5	0246-sto&Stort hout, geschilderd (o.b.v. 99% Waste wood, untreated en 1% Waste paint {EU}) treatment of, sanitary landfill Cut-off, U)	wax	3,00E-04
			indoors	3,00E-04
	95	0263-avC&Verbranden hout, verontreinigd (13,99 MJ/kg) (o.b.v. Waste building wood, chrome preserved {CH}) treatment of, municipal incineration Cut-off, U)	wax	5,68E-03
			indoors	5,74E-03

Wooden pallets	5	0245-sto&Stort hout, 'schoon' (o.b.v. Waste wood, untreated {Europe without Switzerland}) treatment of waste wood, untreated, sanitary landfill Cut-off, U)	wax	2,20E-03
			indoors	2,22E-03
	80	0262-avC&Verbranden hout, 'schoon' (13,99 MJ/kg) (o.b.v. Waste wood, untreated {CH}) treatment of, municipal incineration Cut-off, U)	wax	3,52E-02
			indoors	3,56E-02
	15	0284-reC&Verspanen hout (o.b.v. Wood chipping, industrial residual wood, stationary electric chipper {GLO}) market for Cut-off, U)	wax	6,61E-03
			indoors	6,67E-03
Card-board	15	0245-sto&Stort hout, 'schoon' (o.b.v. Waste wood, untreated {Europe without Switzerland}) treatment of waste wood, untreated, sanitary landfill Cut-off, U)	wax	1,47E-04
			indoors	1,48E-04
	85	0297-avC&Verbranden organisch afval (4,29 MJ/kg) (o.b.v. Biowaste {GLO}) treatment of biowaste, municipal incineration Cut-off, U)	wax	2,79E-03
			indoors	2,81E-03
PE	10	0312-sto&Stort PP, ongecontroleerd ('laten zitten') (o.b.v. Waste polypropylene {GLO}) treatment of waste polypropylene, unsanitary landfill, moist infiltration class (300mm) Cut-off, U)	wax	2,51E-04
			indoors	2,54E-04
	85	0264-avC&Verbranden kunststoffen (28,67 MJ/kg) (o.b.v. o.b.v. mix 21% PE, 21% PP, 20% PVC, 17% PS en 21% mixture)	wax	2,14E-03
			indoors	2,16E-03
	5	0286-reC&verwerking kunststof voor recycling (o.b.v. Waste polyethylene, for recycling, sorted {Europe without Switzerland}) market for waste polyethylene, for recycling, sorted Cut-off, U)	wax	1,26E-04
			indoors	1,27E-04

Table 10: GUTEX wood fibre insulation, outgoing flows construction phase for 1 kg of product

Use phase (BI-7)

GUTEX wood fibre insulation has a lifespan of 75 years when correctly applied as insulation material in a building. This period is equal to the Dutch standard for residential buildings. During this period, no additional maintenance is needed.

End-of-life phase (CI-4)

Disassembly and demolition (C1)

Disassembly and demolition takes place manually, there is no industrial process.

Transport (C2)

Transport phase assumptions: the default value according to the bepalingmethode 1.1 is used. This is 50 km to sorting installation and 100 km from demolition or sorting location to processing location. Selection of the means of transport according to the bepalingmethode version 1.1 (Chapter 2.6.3.7, p. 20).

Assumptions in the final processing phase:

Material	Means of transport	km	Explanation
Material from demolition	0001-tra&Transport, vrachtwagen (o.b.v. Transport, freight, lorry, unspecified {GLO}) market group for transport, freight, lorry, unspecified Cut-off, U)	50	Transport to sorting
		50	Transport from sorting to landfill
		100	Transport from sorting to AVC
		50	Transport for recycling

Table 11: Transport waste disposal GUTEX wood fibre insulation

Waste treatment (C3-C4)

For waste processing, the distribution below and the scenarios chosen have been taken into account.

Product	%	Process	Product	Amount/kg
GUTEX wood fibre board	5	0246-sto&Stort hout, geschilderd (o.b.v. 99% Waste wood, untreated en 1% Waste paint {EU}) treatment of, sanitary landfill Cut-off, U)	wax	9,50E-01
			indoors	9,50E-01
	95	0263-avC&Verbranden hout, verontreinigd (13,99 MJ/kg) (o.b.v. Waste building wood, chrome preserved {CH}) treatment of, municipal incineration Cut-off, U)	wax	5,00E-02
			indoors	5,00E-02

Table 12: Waste processing scenarios GUTEX wood fibre insulation

Benefits and burdens outside the system boundary (D)

The benefits and burdens outside the system boundary relate to combustion in which energy use is avoided. The recycling and reuse of the attachment is also part of the benefits and burdens outside the system boundary. In the bepalingmethode version 1.1 article 2.6.3.7 page 22, the exact values for the various materials are listed.

Benefits and burdens outside the system boundary

Material	Phase	Process	Product	Amount/kg
Cardboard, wood fibre, pallets	A5 End of life	0268-avD&Vermeden energieproductie AVI, o.b.v. HERNIEUWBARE grondstoffen, 18% elektrisch en 31% thermisch (per MJ LHV)	wax	6,17E-01 MJ
			indoors	6,23E-01 MJ
Pallets	A5 End of life	0276-reD&Module D, houtspaanders, per kg NETTO geleverd (o.b.v. Wood chips, dry, measured as dry mass {RER} three layered laminated board production Cut-off, U)	wax	6,61E-03 kg
			indoors	6,67E-03 kg
PE	A5 End of life	0267-avD&Vermeden energieproductie AVI, o.b.v. FOSSIELE grondstoffen, 18% elektrisch en 31% thermisch (per MJ LHV)	wax	9,10E-02 MJ
			indoors	9,20E-02 MJ
		0278-reD&Module D, PE, per kg NETTO geleverd (o.b.v. vermeden Polyethylene, high density, granulate {RER} production Cut-off, U en kwaliteitsfactor 0,67)	wax	1,26E-04 kg
			indoors	1,30E-04 kg
Wood fibre	C End of life	0268-avD&Vermeden energieproductie AVI, o.b.v. HERNIEUWBARE grondstoffen, 18% elektrisch en 31% thermisch (per MJ LHV)	wax	1,33E+01 MJ
			indoors	1,33E+01 MJ

Table 13: Benefits and burdens outside the system boundary for GUTEX wood fibre insulation

LCA results

LCA results for GUTEX wood fibre insulation with wax, for outdoor application

Environmental indicators per FU (m²) EN 15804 +A1, GUTEX wood fibre insulation with wax

Potential Environmental Impacts	Production	Construction process stage		Use stage					End-of-life stage				D Reuse, recovery, recycling	
	A1 Raw material A2 Transport A3 manufacturing	A4 Transport	A5 Installation	B1 Use	B2 Maintenance	B3 Repair	B4 Replacement	B5 Refurbishment	C1 Deconstruction / demolition	C2 Transport	C3 Waste processing	C4 Disposal		
ADPE (kg Sb-eq)	2,56E-04	6,94E-05	2,83E-07	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,24E-05	1,28E-06	1,33E-07	-2,02E-05
ADPF (kg SB-eq)	1,28E-01	2,00E-02	1,33E-04	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	3,57E-03	1,11E-03	1,42E-04	-8,81E-03
GWP (kg CO ₂ -eq)	1,48E+01	2,72E+00	1,52E-01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	4,85E-01	2,01E-01	8,85E-02	-1,44E+00
ODP (kg CFC 11-eq)	1,60E-06	4,82E-07	5,53E-09	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	8,61E-08	2,38E-08	3,07E-09	-4,02E-07
POCP (kg C ₂ H ₄ -eq)	1,22E-02	1,64E-03	4,66E-05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,93E-04	9,06E-04	2,76E-05	-4,41E-03
AP (kg SO ₂ -eq)	4,46E-02	1,19E-02	2,74E-04	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,13E-03	4,72E-03	8,16E-05	-2,82E-02
EP (kg (PO ₄) ₃ -eq)	9,11E-03	2,35E-03	6,75E-05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	4,19E-04	1,23E-03	3,35E-05	-9,35E-03
HTP (kg 1,4-DB-eq)	5,02E+00	1,14E+00	3,63E-02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,04E-01	5,67E-01	7,64E-03	-2,45E+00
FAETP (kg 1,4-DB-eq)	2,30E-01	3,34E-02	9,58E-04	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	5,97E-03	2,51E-02	1,50E-04	-5,12E-02
MAETP (kg 1,4-DB-eq)	5,17E+02	1,20E+02	2,46E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,15E+01	1,37E+01	5,42E-01	-6,91E+01
TETP (kg 1,4-DB-eq)	2,30E-02	4,04E-03	6,02E-05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	7,22E-04	5,70E-04	2,48E-05	-1,56E-02

ADPE = Abiotic Depletion Potential – Elements; ADPF = Abiotic Depletion Potential – Fossil Fuels; GWP = Global warming Potential; ODP = Ozone Depletion Potential; POCP = Photochemical Ozone Creation; AP = Acidification Potential for Soil and Water; EP = Eutrophication Potential; HTP = Human Toxicity Potential ; FAETP = Fresh Aquatic Ecotoxicity Potential ; MAETP = Marine Aquatic Ecotoxicity Potential; TETP = Terrestrial Ecotoxicity Potential

Table 14: Environmental indicators per FU (m²) EN 15804 +A1, GUTEX wood fibre insulation with wax

Core Environmental Indicators per FU (m²) EN 15804 +A2, GUTEX wood fibre insulation with wax

Potential Environmental Impacts	Production	Construction process stage		Use stage					End-of-life stage				D Reuse, recovery, recycling
	A1 Raw material A2 Transport A3 manufacturing	A4 Transport	A5 Installation	B1 Use	B2 Maintenance	B3 Repair	B4 Replacement	B5 Refurbishment	C1 Deconstruction / demolition	C2 Transport	C3 Waste processing	C4 Disposal	
CC total (kg CO2 eq)	-2,88E+01	2,74E+00	1,59E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	4,90E-01	4,28E+01	1,30E-01	-1,52E+00
CC fossil (kg CO2 eq)	1,53E+01	2,74E+00	1,48E-01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	4,89E-01	2,04E-01	1,39E-02	-1,46E+00
CC biogenic (kg CO2 eq)	-4,41E+01	1,26E-03	1,44E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,26E-04	4,25E+01	1,17E-01	-4,05E-02
CC luluc (kg CO2 eq)	2,55E-02	1,00E-03	1,77E-05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,79E-04	5,58E-05	6,08E-06	-1,57E-02
ODP (kg CFC 11 eq)	1,80E-06	6,05E-07	5,68E-09	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,08E-07	2,62E-08	3,83E-09	-4,10E-07
AP (mol H+ eq)	5,56E-02	1,59E-02	3,92E-04	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,84E-03	6,97E-03	1,08E-04	-4,44E-02
EP – freshwater (kg P eq)	5,22E-04	2,76E-05	7,52E-07	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	4,94E-06	4,17E-06	2,59E-07	-1,40E-04
EP – marine (kg N eq)	1,47E-02	5,60E-03	1,68E-04	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,00E-03	3,24E-03	6,94E-05	-1,30E-02
EP – terrestrial (mol N eq)	1,32E-01	6,17E-02	1,89E-03	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,10E-02	3,71E-02	3,98E-04	-2,13E-01
POCP (kg NMVOC eq)	5,08E-02	1,76E-02	4,98E-04	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	3,15E-03	9,71E-03	1,42E-04	-3,74E-02
ADP Elements (kg Sb eq)	2,56E-04	6,94E-05	2,83E-07	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,24E-05	1,28E-06	1,33E-07	-2,02E-05
ADP fossil fuels (MJ)	2,48E+02	4,13E+01	2,51E-01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	7,38E+00	2,07E+00	2,93E-01	-1,81E+01
WDP (m ³ water eq deprived)	2,60E+01	1,48E-01	1,19E-02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,64E-02	7,28E-02	1,26E-02	-1,57E-01

CC total = Climate Change total; CC fossil = Climate Change fossil; CC biogenic= Climate Change biogenic; CC-luluc = Climate Change land use and land use change; ODP = Ozone Depletion Potential; AP = Acidification Potential for Soil and Water; EP = Eutrophication Potential; POCP = Photochemical Ozone Creation; ADPE = Abiotic Depletion Potential – Elements; ADPF = Abiotic Depletion Potential – Fossil Fuels; WDP = water use (Water user) deprivation potential, deprivation-weighted water consumption)

Table 15: Core Environmental Indicators per FU (m²) EN 15804 +A2, GUTEX wood fibre insulation with wax

Additional Environmental Indicators per FU (m²) EN 15804 +A2, GUTEX wood fibre insulation with wax

Potential Environmental Impacts	A1 t/m A3	A4	A5	B1	B2	B3	B4	B5	C1	C2	C3	C4	D
<i>PM (disease incidence)</i>	7,04E-07	2,46E-07	3,25E-09	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	4,40E-08	5,62E-08	2,04E-09	-6,01E-07
<i>IRHH (kg U235 eq)</i>	2,93E-01	1,73E-01	8,97E-04	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	3,09E-02	5,39E-03	1,15E-03	-6,99E-02
<i>ETF (CTUe)</i>	5,16E+02	3,68E+01	2,07E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	6,58E+00	6,06E+00	2,94E-01	-4,30E+02
<i>HTCE (CTUh)</i>	5,95E-08	1,20E-09	7,92E-10	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,14E-10	8,63E-08	8,17E-12	-4,94E-09
<i>HTnCE (CTUh)</i>	6,12E-07	4,03E-08	1,73E-09	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	7,20E-09	2,12E-08	3,14E-10	-1,80E-07
<i>Land Use Related impacts (dimensionless)</i>	2,56E+03	3,58E+01	1,22E-01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	6,40E+00	7,19E-01	6,94E-01	-1,70E+03
<i>PERE (MJ, net calorific value)</i>	5,17E+02	5,17E-01	-1,44E+01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	9,24E-02	-3,11E+02	5,16E-03	-3,55E+02
<i>PERM (MJ, net calorific value)</i>	1,40E-01	0,00E+00	1,44E+01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	3,11E+02	0,00E+00	0,00E+00
<i>PERT (MJ, net calorific value)</i>	5,17E+02	5,17E-01	1,87E-02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	9,24E-02	9,59E-02	5,16E-03	-3,55E+02
<i>PENRE (MJ, net calorific value)</i>	2,69E+02	4,39E+01	-1,86E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	7,84E+00	2,23E+00	3,12E-01	-1,93E+01
<i>PENRM (MJ, net calorific value)</i>	9,36E-02	0,00E+00	2,13E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
<i>PENRT (MJ, net calorific value)</i>	2,69E+02	4,39E+01	2,68E-01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	7,84E+00	2,23E+00	3,12E-01	-1,93E+01
<i>SM (kg)</i>	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
<i>RSF (MJ, net calorific value)</i>	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
<i>NRSF (MJ, net calorific value)</i>	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
<i>FW (m³ water eq)</i>	6,15E-01	5,03E-03	7,37E-04	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	8,99E-04	1,09E-02	3,06E-04	-4,55E-03

PM = Particulate Matter; IRHH = Ionizing Radiation – human health effects; ETF = Ecotoxicity – freshwater; HTCE = Human Toxicity – cancer effects; HTnCE = Human Toxicity – non cancer effects; PERE = use of renewable primary energy excluding renewable primary energy resources used as raw materials; PERM = Use of renewable primary energy resources used as raw materials; PERT = Total use of renewable primary energy resources; PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials; PENRM = Use of non-renewable primary energy resources used as raw materials; PENRT = Total use of non-renewable primary energy resources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Net use of fresh water

Table 16: Additional Environmental Indicators per FU (m²) EN 15804 +A2, GUTEX wood fibre insulation with wax

Environmental information describing output flows and waste categories per FU (m²) EN 15804 +A2, GUTEX wood fibre insulation with wax

Potential Environmental Impacts	A1 t/m A3	A4	A5	B1	B2	B3	B4	B5	C1	C2	C3	C4	D
<i>Hazardous waste disposed (kg/FU)</i>	2,74E-04	1,05E-04	5,54E-07	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,87E-05	1,33E-05	4,51E-07	-6,03E-05
<i>Non-hazardous waste disposed (kg)</i>	1,55E+00	2,62E+00	8,10E-02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	4,68E-01	1,93E-01	1,17E+00	-6,37E-01
<i>Radioactive waste disposed (kg)</i>	3,55E-04	2,71E-04	8,98E-07	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	4,85E-05	6,39E-06	1,74E-06	-1,07E-04
<i>Components for reuse (kg)</i>	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
<i>Materials for recycling (kg)</i>	2,34E-04	0,00E+00	1,57E-01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
<i>Materials for energy recovery (kg)</i>	1,17E-02	0,00E+00	9,39E-01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,22E+01	0,00E+00	0,00E+00
<i>Exported energy Heat (MJ)</i>	4,21E-02	0,00E+00	2,98E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	5,60E+01	0,00E+00	0,00E+00
<i>Exported energy Energy (MJ)</i>	7,25E-02	0,00E+00	5,14E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	9,64E+01	0,00E+00	0,00E+00

Table 17: Environmental information describing output flows and waste categories per FU (m²) EN 15804 +A2, GUTEX wood fibre insulation with wax

LCA results for GUTEX wood fibre insulation without wax, for indoor application

Environmental indicators per FU (m²) EN 15804 +A1, GUTEX wood fibre insulation indoors

Potential Environmental Impacts	Production	Construction process stage		Use stage					End-of-life stage				D Reuse, recovery, recycling	
	A1 Raw material A2 Transport A3 manufacturing	A4 Transport	A5 Installation	B1 Use	B2 Maintenance	B3 Repair	B4 Replacement	B5 Refurbishment	C1 Deconstruction / demolition	C2 Transport	C3 Waste processing	C4 Disposal		
ADPE (kg Sb-eq)	2,52E-04	6,88E-05	2,83E-07	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,23E-05	1,26E-06	1,31E-07	-2,00E-05
ADPF (kg SB-eq)	1,23E-01	1,98E-02	1,33E-04	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	3,54E-03	1,10E-03	1,41E-04	-8,74E-03
GWP (kg CO ₂ -eq)	1,46E+01	2,69E+00	1,52E-01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	4,81E-01	1,99E-01	8,76E-02	-1,43E+00
ODP (kg CFC 11-eq)	1,59E-06	4,78E-07	5,53E-09	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	8,53E-08	2,36E-08	3,04E-09	-3,99E-07
POCP (kg C ₂ H ₄ -eq)	1,21E-02	1,62E-03	4,66E-05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,90E-04	8,97E-04	2,74E-05	-4,37E-03
AP (kg SO ₂ -eq)	4,34E-02	1,18E-02	2,74E-04	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,11E-03	4,68E-03	8,09E-05	-2,80E-02
EP (kg (PO ₄) ₃ -eq)	9,01E-03	2,32E-03	6,75E-05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	4,15E-04	1,21E-03	3,32E-05	-9,26E-03
HTP (kg 1,4-DB-eq)	4,95E+00	1,13E+00	3,63E-02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,02E-01	5,61E-01	7,57E-03	-2,42E+00
FAETP (kg 1,4-DB-eq)	2,29E-01	3,31E-02	9,58E-04	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	5,91E-03	2,48E-02	1,49E-04	-5,07E-02
MAETP (kg 1,4-DB-eq)	5,13E+02	1,19E+02	2,45E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,13E+01	1,36E+01	5,37E-01	-6,85E+01
TETP (kg 1,4-DB-eq)	2,28E-02	4,01E-03	6,02E-05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	7,16E-04	5,64E-04	2,46E-05	-1,55E-02

ADPE = Abiotic Depletion Potential – Elements; ADPF = Abiotic Depletion Potential – Fossil Fuels; GWP = Global warming Potential; ODP = Ozone Depletion Potential; POCP = Photochemical Ozone Creation; AP = Acidification Potential for Soil and Water; EP = Eutrophication Potential; HTP = Human Toxicity Potential ; FAETP = Fresh Aquatic Ecotoxicity Potential ; MAETP = Marine Aquatic Ecotoxicity Potential; TETP = Terrestrial Ecotoxicity Potential

Table 18: Environmental indicators per FU (m²) EN 15804 +A1, GUTEX wood fibre insulation indoors

Core Environmental Indicators per FU (m²) EN 15804 +A2, GUTEX wood fibre insulation indoors

Potential Environmental Impacts	Production	Construction process stage		Use stage					End-of-life stage				D Reuse, recovery, recycling
	A1 Raw material A2 Transport A3 manufacturing	A4 Transport	A5 Installation	B1 Use	B2 Maintenance	B3 Repair	B4 Replacement	B5 Refurbishment	C1 Deconstruction / demolition	C2 Transport	C3 Waste processing	C4 Disposal	
CC total (kg CO2 eq)	-2,89E+01	2,72E+00	1,59E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	4,85E-01	4,27E+01	1,29E-01	-1,50E+00
CC fossil (kg CO2 eq)	1,51E+01	2,71E+00	1,48E-01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	4,85E-01	2,02E-01	1,38E-02	-1,45E+00
CC biogenic (kg CO2 eq)	-4,41E+01	1,25E-03	1,44E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,24E-04	4,25E+01	1,15E-01	-3,93E-02
CC luluc (kg CO2 eq)	2,55E-02	9,95E-04	1,77E-05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,78E-04	5,52E-05	6,02E-06	-1,55E-02
ODP (kg CFC 11 eq)	1,80E-06	5,99E-07	5,68E-09	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,07E-07	2,59E-08	3,80E-09	-4,07E-07
AP (mol H+ eq)	5,42E-02	1,57E-02	3,92E-04	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,81E-03	6,91E-03	1,07E-04	-4,40E-02
EP – freshwater (kg P eq)	5,18E-04	2,74E-05	7,52E-07	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	4,89E-06	4,13E-06	2,56E-07	-1,39E-04
EP – marine (kg N eq)	1,45E-02	5,55E-03	1,68E-04	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	9,91E-04	3,21E-03	6,87E-05	-1,29E-02
EP – terrestrial (mol N eq)	1,30E-01	6,12E-02	1,89E-03	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,09E-02	3,68E-02	3,94E-04	-2,11E-01
POCP (kg NMVOC eq)	4,99E-02	1,75E-02	4,97E-04	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	3,12E-03	9,61E-03	1,41E-04	-3,71E-02
ADP Elements (kg Sb eq)	2,52E-04	6,88E-05	2,83E-07	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,23E-05	1,26E-06	1,31E-07	-2,00E-05
ADP fossil fuels (MJ)	2,37E+02	4,09E+01	2,51E-01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	7,31E+00	2,05E+00	2,90E-01	-1,80E+01
WDP (m ³ water eq deprived)	5,08E+00	1,46E-01	1,19E-02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,62E-02	7,21E-02	1,25E-02	-1,56E-01

CC total = Climate Change total; CC fossil = Climate Change fossil; CC biogenic= Climate Change biogenic; CC-luluc = Climate Change land use and land use change; ODP = Ozone Depletion Potential; AP = Acidification Potential for Soil and Water; EP = Eutrophication Potential; POCP = Photochemical Ozone Creation; ADPE = Abiotic Depletion Potential – Elements; ADPF = Abiotic Depletion Potential – Fossil Fuels; WDP = water use (Water user) deprivation potential, deprivation-weighted water consumption)

Table 19: Core Environmental Indicators per FU (m²) EN 15804 +A2, GUTEX wood fibre insulation indoors

Additional Environmental Indicators per FU (m²) EN 15804 +A2, GUTEX wood fibre insulation indoors

Potential Environmental Impacts	A1 t/m A3	A4	A5	B1	B2	B3	B4	B5	C1	C2	C3	C4	D
<i>PM (disease incidence)</i>	6,91E-07	2,44E-07	3,25E-09	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	4,35E-08	5,56E-08	2,02E-09	-5,96E-07
<i>IRHH (kg U235 eq)</i>	2,91E-01	1,72E-01	8,97E-04	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	3,06E-02	5,34E-03	1,14E-03	-6,92E-02
<i>ETF (CTUe)</i>	5,12E+02	3,65E+01	2,07E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	6,52E+00	6,00E+00	2,91E-01	-4,26E+02
<i>HTCE (CTUh)</i>	5,94E-08	1,18E-09	7,92E-10	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,12E-10	8,54E-08	8,09E-12	-4,90E-09
<i>HTnCE (CTUh)</i>	6,10E-07	3,99E-08	1,73E-09	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	7,13E-09	2,10E-08	3,11E-10	-1,78E-07
<i>Land Use Related impacts (dimensionless)</i>	2,56E+03	3,55E+01	1,22E-01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	6,34E+00	7,12E-01	6,87E-01	-1,68E+03
<i>PERE (MJ, net calorific value)</i>	5,17E+02	5,12E-01	-1,44E+01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	9,16E-02	-3,08E+02	5,11E-03	-3,51E+02
<i>PERM (MJ, net calorific value)</i>	1,39E-01	0,00E+00	1,44E+01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	3,08E+02	0,00E+00	0,00E+00
<i>PERT (MJ, net calorific value)</i>	5,17E+02	5,12E-01	1,87E-02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	9,16E-02	9,50E-02	5,11E-03	-3,51E+02
<i>PENRE (MJ, net calorific value)</i>	2,57E+02	4,35E+01	-1,86E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	7,76E+00	2,21E+00	3,09E-01	-1,92E+01
<i>PENRM (MJ, net calorific value)</i>	9,27E-02	0,00E+00	2,13E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
<i>PENRT (MJ, net calorific value)</i>	2,57E+02	4,35E+01	2,68E-01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	7,76E+00	2,21E+00	3,09E-01	-1,92E+01
<i>SM (kg)</i>	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
<i>RSF (MJ, net calorific value)</i>	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
<i>NRSF (MJ, net calorific value)</i>	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
<i>FW (m³ water eq)</i>	1,28E-01	4,99E-03	7,37E-04	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	8,91E-04	1,08E-02	3,03E-04	-4,51E-03

PM = Particulate Matter; IRHH = Ionizing Radiation – human health effects; ETF = Ecotoxicity – freshwater; HTCE = Human Toxicity – cancer effects; HTnCE = Human Toxicity – non cancer effects; PERE = use of renewable primary energy excluding renewable primary energy resources used as raw materials; PERM = Use of renewable primary energy resources used as raw materials; PERT = Total use of renewable primary energy resources; PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials; PENRM = Use of non-renewable primary energy resources used as raw materials; PENRT = Total use of non-renewable primary energy resources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Net use of fresh water

Table 20: Additional Environmental Indicators per FU (m²) EN 15804 +A2, GUTEX wood fibre insulation indoors

Environmental information describing output flows and waste categories per FU (m²) EN 15804 +A2, GUTEX wood fibre insulation indoors

Potential Environmental Impacts	A1 t/m A3	A4	A5	B1	B2	B3	B4	B5	C1	C2	C3	C4	D
<i>Hazardous waste disposed (kg/FU)</i>	2,72E-04	1,04E-04	5,54E-07	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,85E-05	1,31E-05	4,47E-07	-5,97E-05
<i>Non-hazardous waste disposed (kg)</i>	1,54E+00	2,60E+00	8,09E-02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	4,64E-01	1,91E-01	1,16E+00	-6,31E-01
<i>Radioactive waste disposed (kg)</i>	3,52E-04	2,69E-04	8,98E-07	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	4,80E-05	6,32E-06	1,73E-06	-1,06E-04
<i>Components for reuse (kg)</i>	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
<i>Materials for recycling (kg)</i>	2,32E-04	0,00E+00	1,58E-01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
<i>Materials for energy recovery (kg)</i>	1,16E-02	0,00E+00	9,39E-01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,20E+01	0,00E+00	0,00E+00
<i>Exported energy Heat (MJ)</i>	4,17E-02	0,00E+00	2,98E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	5,54E+01	0,00E+00	0,00E+00
<i>Exported energy Energy (MJ)</i>	7,18E-02	0,00E+00	5,14E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	9,55E+01	0,00E+00	0,00E+00

Table 21: Environmental information describing output flows and waste categories per FU (m²) EN 15804 +A2, GUTEX wood fibre insulation indoors

Interpretation LCA results

Hotspot analysis GUTEX wood fibre insulation

Hotspot analysis GUTEX wood fibre insulation with wax, for outdoor application

In order to be able to interpret the LCA results, the following analyses have been made so that the client can see where the greatest improvement can be achieved. All graphics are based upon the Simapro weighting set for the NMD and in kg product.

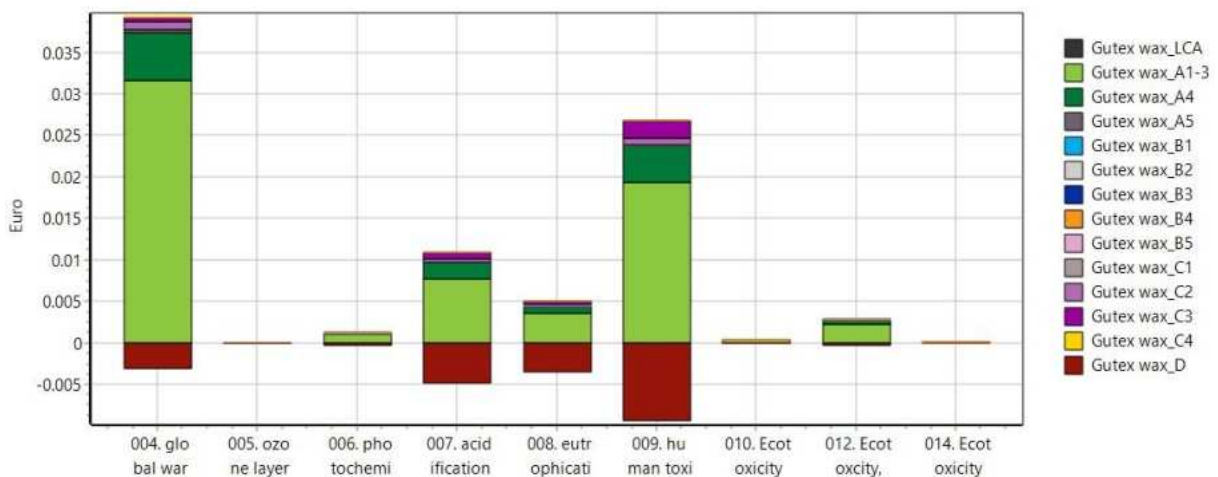


Figure 4: Environmental impact per input, entire LCA, GUTEX wood fibre insulation with wax

Figure 4 shows that the major impact is in the production phase (A1-3). In this the categories 'human toxicity' and 'global warming' are giving the highest impacts. Human toxicity is also the impact category with the highest negative score, module D, caused by avoided energy production (brown color)

Production phase GUTEX wood fibre insulation with wax, for outdoor application

If we zoom in on the production phase, we can see which material or process causes these high scores. Products causing the highest impact are:

- polyurethane adhesive (dark green)
- Combined heating plant (sea green for electricity and dark blue for heat)
- EUR-flat pallet (light blue)

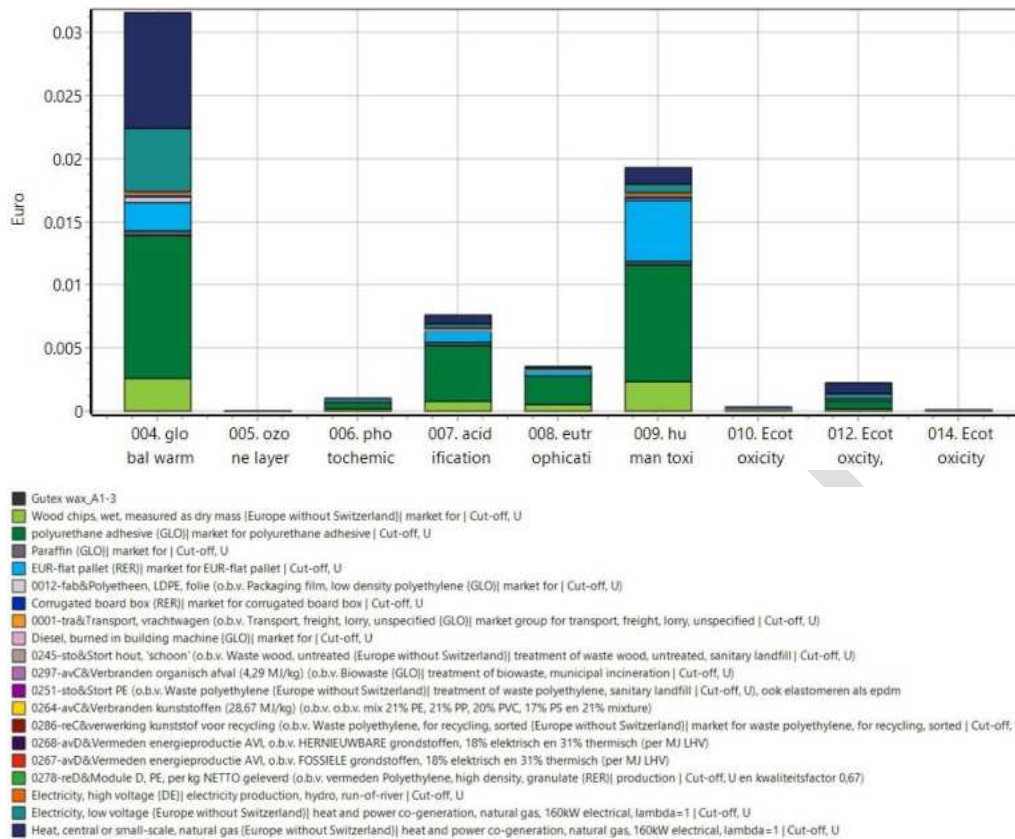


Figure 5: Environmental impact per input, Module A1-3 GUTEX wood fibre insulation with wax

Hotspot analysis GUTEX wood fibre insulation without wax, for indoor application

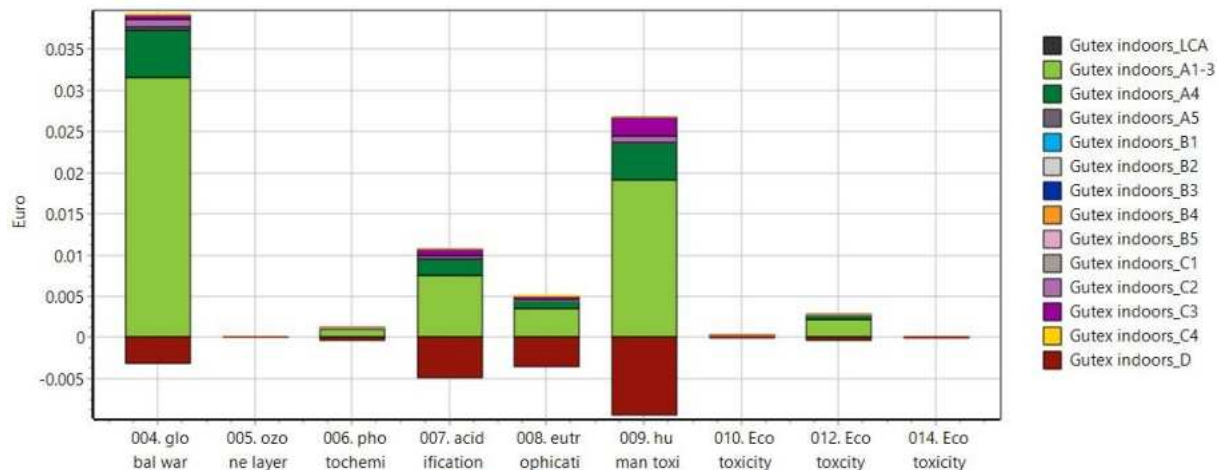


Figure 6: Environmental impact per input, entire LCA, GUTEX wood fibre insulation indoors

Figure 6 shows that the major impact is in the production phase (A1-3). In this the categories ‘human toxicity’ and ‘global warming’ are giving the highest impacts. Human toxicity is also the impact category with the highest negative score, module D, caused by avoided energy production (brown color)

Production phase GUTEX wood fibre insulation without wax, for indoor application

If we zoom in on the production phase, we can see which material or process causes these high scores. Products causing the highest impact are:

- polyurethane adhesive (dark green)
- EUR-flat pallet (dark grey)
- Combined heat/power generation (orange for electricity and sea green for heat)

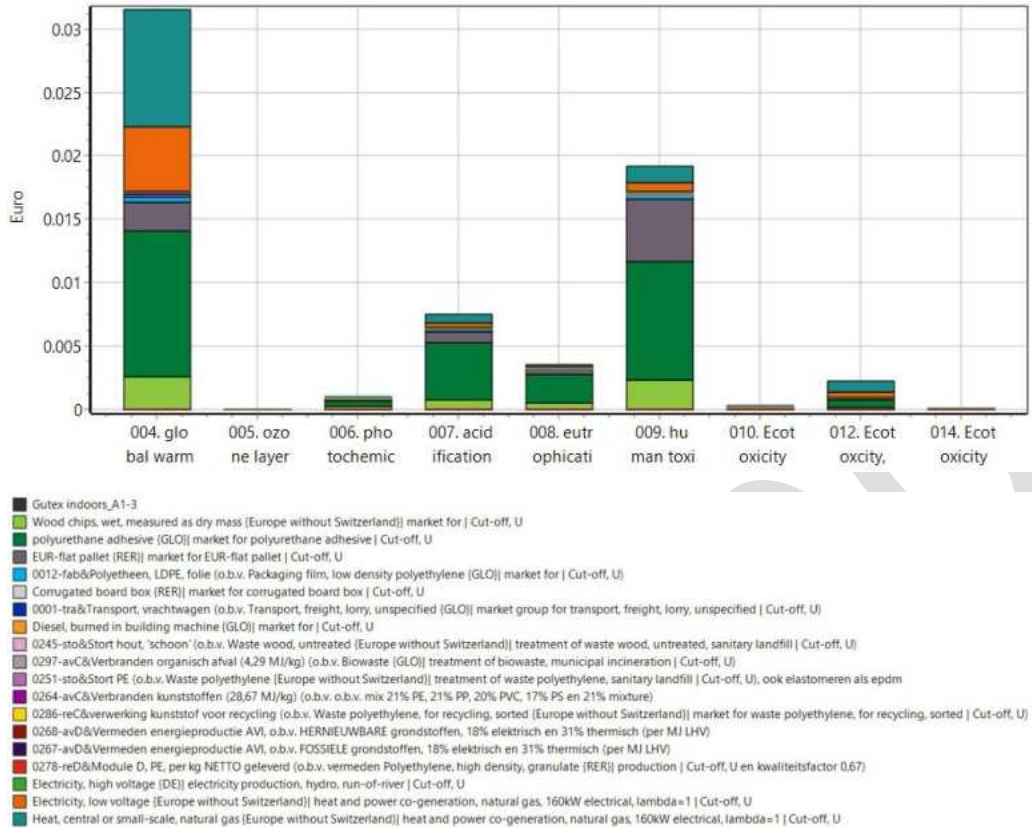


Figure 7: Environmental impact per input, Module A1-3 GUTEX wood fibre insulation indoors

Sensitivity analysis

In order to be able to interpret the LCA results, the environmental impact of the two processes with the highest impact were studied, namely the adhesive and the energy source. In the figure below, the impact of the polyurethane adhesive as used in this study was compared with epoxy resin and with polyvinyl acetate.

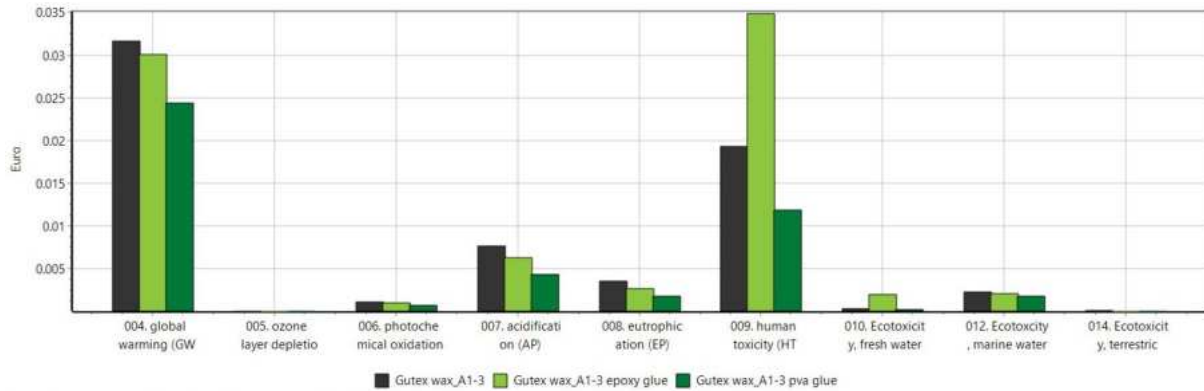


Figure 8: Comparison of environmental impact of different adhesives: PUR (black, used in this study), epoxy (light green) and PVA (dark green)

Figure 8 shows that a different type of adhesive can reduce the environmental impact of the wood fibre insulation.

For the energy source, the impact of CHP on gas was compared to CHP on wood pellets and CHP on wood chips. The latter process uses a much larger boiler, so the processes are not completely comparable.

Figure 9 shows the results.

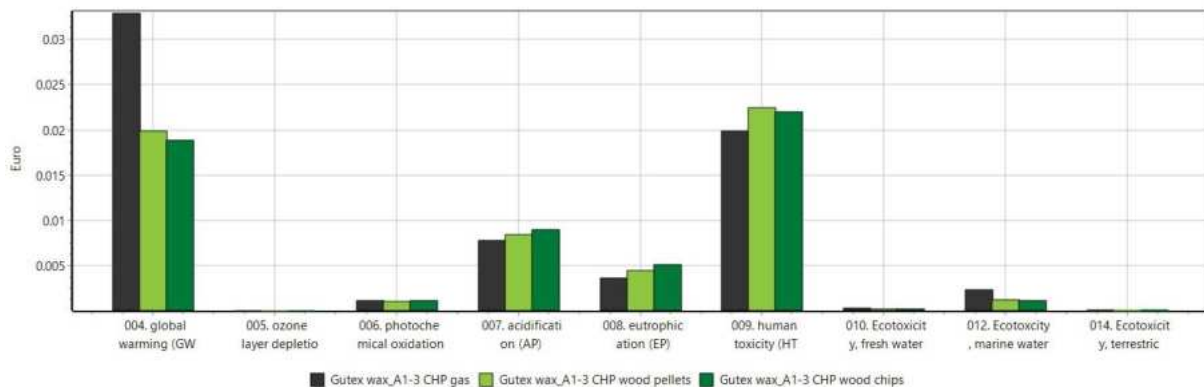


Figure 9: Comparison of environmental impact of different energy sources: natural gas (black, used in this study), wood pellets (light green) and wood chips (dark green)

Generating heat and power with wood pellets or chips has a positive impact on global warming as compared to natural gas. The impacts on acidification, eutrophication and human toxicity, however, are higher.

MKI results

Below are the results of the MKI, the MKI calculation is done only for the 11 indicators from the EN18504 +A1. In the coming years this shall be replaced by a weighting for the EN 15804 +A2 impact categories.

We opted for analyses from Simapro and for converting LCA results into shadow costs according to the Environmental cost indicator from the Bepalingsmethode version 1.1. Partial analyses have been carried out to clarify where the profit points lie, based on the impact calculations.

MKI table GUTEX wood fibre insulation with wax, for outdoor application

Impact categories	Units	A1-3	A4	A5	B1-5	C1	C2	C3	C4	D	Total
Abiotic depletion, non fuel	kg antimoine eq.	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Abiotic depletion, fuel	kg antimoine eq.	0,02	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,02
Global warming (GWP100)	kg CO2 eq.	0,74	0,14	0,01	0,00	0,00	0,02	0,01	0,00	-0,07	0,85
Ozone layer depletion (ODP)	kg CFK-11 eq.	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Photochemical oxidation	kg ethyleen eq.	0,02	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-0,01	0,02
Acidification	kg SO2 eq.	0,18	0,05	0,00	0,00	0,00	0,01	0,02	0,00	-0,11	0,14
Eutrophication	kg PO4- eq.	0,08	0,02	0,00	0,00	0,00	0,00	0,01	0,00	-0,08	0,03
Human toxicity	kg 1,4- DB eq.	0,45	0,10	0,00	0,00	0,00	0,02	0,05	0,00	-0,22	0,41
Fresh water aquatic ecotox.	kg 1,4- DB eq.	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01
Marine aquatic ecotoxicity	kg 1,4- DB eq.	0,05	0,01	0,00	0,00	0,00	0,00	0,00	0,00	-0,01	0,06
Terrestrial ecotoxicity	kg 1,4- DB eq.	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Totaal	€	1,56	0,33	0,01	0,00	0,00	0,06	0,10	0,01	-0,51	1,55

Table 22: MKI calculation in € per FU of GUTEX wood fibre insulation with wax

MKI table GUTEX wood fibre insulation without wax, for indoor application

Impact categories	Units	A1-3	A4	A5	B1-5	C1	C2	C3	C4	D	Total
Abiotic depletion, non fuel	kg antimoine eq.	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Abiotic depletion, fuel	kg antimoine eq.	0,02	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,02
Global warming (GWP100)	kg CO2 eq.	0,73	0,13	0,01	0,00	0,00	0,02	0,01	0,00	-0,07	0,84
Ozone layer depletion (ODP)	kg CFK-11 eq.	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Photochemical oxidation	kg ethyleen eq.	0,02	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-0,01	0,02
Acidification	kg SO2 eq.	0,17	0,05	0,00	0,00	0,00	0,01	0,02	0,00	-0,11	0,14
Eutrophication	kg PO4- eq.	0,08	0,02	0,00	0,00	0,00	0,00	0,01	0,00	-0,08	0,03
Human toxicity	kg 1,4- DB eq.	0,45	0,10	0,00	0,00	0,00	0,02	0,05	0,00	-0,22	0,40
Fresh water aquatic ecotox.	kg 1,4- DB eq.	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01
Marine aquatic ecotoxicity	kg 1,4- DB eq.	0,05	0,01	0,00	0,00	0,00	0,00	0,00	0,00	-0,01	0,06
Terrestrial ecotoxicity	kg 1,4- DB eq.	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Totaal	€	1,53	0,32	0,01	0,00	0,00	0,06	0,09	0,01	-0,50	1,52

Table 23: MKI calculation in € per FU of GUTEX wood fibre insulation indoors

In both MKI calculations, global warming and human toxicity are the most determining in the total MKI.

Accountability

The LCA study was conducted by Agrodome B.V. in 2022/2023.

The data provided by GUTEX have been extensively discussed with Agrodome B.V.

The final version of the LCA study has been submitted to LBP|Sight for external peer review.

The LCA is carried out according to EN 15804 +A1 and +A2 in compliance with the standards from the ISO 14000 series: 14025, 14040 and 14044. The LCA report has been tested against the Bepalingsmethode 'Milieuprestatie Bouwwerken', version 1.1 March 2022.

When calculating the environmental impact categories, Simapro, version 9.4.0.2 and environmental data from the NMD-basic processes database, version 3.6 October 2022 and in some cases, namely where no NMD-data were available, the Ecoinvent database, version 3.6.

When making calculations in Simapro, the long-term effects (emissions that can occur after 100 years) are not taken into account, in accordance with the Bepalingsmethode version 1.1. The effects of capital goods and infrastructural processes are included.

References

ISO 14040

ISO 14040:2006-10, Environmental management - Life cycle assessment - Principles and framework; EN ISO 14040:2006

ISO 14044

ISO 14044:2006-10, Environmental management - Life cycle assessment – Requirements and guidelines; EN ISO 14040:2006

ISO 14025

ISO 14025:2011-10: Environmental labels and declarations — Type III environmental declarations — Principles and procedures

EN 15804+A1

EN 15804+A1: 2013: Sustainability of construction works — Environmental Product Declarations — Core rules for the product category of construction products

EN 15804+A2

EN 15804+A2: 2019: Sustainability of construction works — Environmental Product Declarations — Core rules for the product category of construction products

Nationale Milieudatabase

Bepalingsmethode Milieuprestatie Bouwwerken, versie 1.1 March 2022.

Sphera Solutions GmbH

Hintergrundbericht zu der EPD für GUTEX Holzfaserdämmplatten im Trockenverfahren, 2020.

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Declaration Agrodome B.V.

LBP|SIGHT has reviewed this LCA report following the Bepalingsmethode 'Milieuprestatie Bouwwerken' versie 1.1. of Stichting NMD.

This LCA report is approved on 12 October 2023 by René Kraaijenbrink, LBP|Sight.