Environmental Product Declaration

in accordance with ISO 14025

Kronotherm Wood Fibre Insulation Material

Kronoply GmbH

Declaration number
EPD-KRO-2009212-E

Institut Bauen und Umwelt e.V.
www.bau-umwelt.com

Institut Bauen
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Summary

Environmental Product Declaration

Programme holder

Institut Bauen und Umwelt e.V.

(Institute Construction and Environment e.V.)

www.bau-umwelt.com

Declaration holder

Kronoply GmbH
Wittstocker Chaussee 1
D-16909 Heiligengrabe

Declaration number

EPD-KRO-2009212-E

Declared construction products

Kronotherm sound whisper board and Kronotherm flex cavity insulation

This Declaration is an Environmental Product Declaration in accordance with ISO 14025 and describes the environmental features of the construction products outlined here. It intends to promote the development of construction which is compatible with the environment and health. This validated Declaration discloses all of the relevant environmental data. The Declaration is based on the “Wooden materials” PCR document, version 2009-01.

Validity

This Declaration entitles the holder to bear the official stamp of the Institut Bauen und Umwelt. It applies exclusively for the products referred to for one year from the issue date. The declaration holder is liable for the details and documentation upon which the evaluation is based.

Content of the Declaration

The **Declaration** is complete and comprises in detail:
- Product definition and physical construction data
- Details on base materials and material origin
- Description of the product manufacturing process
- Information on product processing
- Data on the utilisation status, extraordinary effects and re-use phase
- Results of the life cycle assessment
- Documentation and tests

Issue date

20. October 2013

Signatures

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

Testing the Declaration

This Declaration and the regulations upon which it is based have been tested by the independent Committee of Experts (SVA) in line with ISO 14025.

Signatures

Prof. Dr.-Ing. Hans-Wolf Reinhardt (Chairman of the SVA)

Dr. Frank Werner (tester appointed by the SVA)

Summary

Environmental Product Declaration

Product description

Kronotherm wood fibre insulation materials are insulation materials pursuant to DIN EN 13171 and are manufactured in a dry process. Wood fibres, binding fibres and ammonium phosphate are used as well as some dispersion paint. The insulation materials are manufactured as panels with a thickness of 5-240 mm; the gross density of these panels is between 55 and 135 kg/m^3.

Area of application

Kronotherm insulation materials have construction inspection approval according to Z-23.15-1581. The applications in accordance with DIN V 4108-10 are regulated for the compliance certificates issued in accordance with this approval. Kronotherm sound and Kronotherm flex are stable wood fibre insulation materials. Kronotherm flex is a flexible cavity insulation material. Pressure stability combined with elastic performance are features of Kronotherm sound whisper boards under parquet and laminate wood floors.

Scope of the LCA

The **Life Cycle Assesment (LCA)** has been performed in accordance with DIN ISO 14040 ff in line with the requirements of the IBU Guidelines governing Type III Declarations. Specific data on the products tested as well as data from the "GaBi 4" data base was applied as a basis. The life cycle assessment comprises the extraction of raw materials and energy, transporting raw materials, the actual manufacturing phase and the End of Life in the biomass power plant with energy recovery.

Results of the LCA

Insulation panel		sound		flex	
Assessment factor	Unit per m³	Production	End of Life	Production	End of Life
Non-regenerative primary energy	[MJ]	3.636	-3.691	918	-915
Regenerative primary energy	[MJ]	3.190	-41	980	-10
Greenhouse Warming Potential (GWP 100 years)	[kg CO_2 equiv.]	-62,8	70,5	-15,9	16,8
Ozone Depletion Potential (ODP)	[kg R11 equiv.]	4,23E-06	-8,59E-06	1,03E-06	-2,13E-06
Acidification Potential (AP)	[kg SO_2 equiv.]	4,11E-01	-1,46E-01	1,55E-01	-2,50E-02
Eutrification Potential (EP)	[kg PO_4 equiv.]	5,08E-02	-2,25E-02	1,71E-02	-4,07E-03
Photochem. Ozone Creation Potential (POCP)	[kg C_2H_4 equiv.]	5,07E-02	-1,78E-02	1,42E-02	-4,02E-03

Created by: Kronoply GmbH

in co-operation with PE INTERNATIONAL, Leinfelden-Echterdingen, Germany

PE INTERNATIONAL
EXPERTS IN SUSTAINABILITY

Documentation and tests

In addition, the following **documentation and tests** are depicted in the Environmental Declaration:

- Formaldehyde - Measuring agency: HFB Engineering GmbH, Leipzig
- Eluate analysis - Measuring agency: Elektro-Physik Aachen GmbH
- Fire gas toxicity - Measuring agency: Elektro-Physik Aachen GmbH
- PCP / Lindan - Measuring agency: WKI Fraunhofer Wilhelm-Klauditz-Institut

Area of applicability This document refers to the Kronotherm wood fibre insulation materials manufactured in the Kronoply plant in D-16909 Heiligengrabe (Germany).

1 Product definition

Product definition Kronotherm wood fibre insulation materials are insulation materials primarily comprising wood fibres. Manufacturing is in a dry process, whereby a mixture of dry wood fibres and binding agents is laid as an infinite mat. The binding fibres are melted in a through-flow oven enabling them to combine with the wood fibres. Depending on the pressure, densities of 40 to 270 kg/m³ can be achieved.

Application Kronotherm insulation materials have construction inspection approval according to Z-23.15-1581. The applications in accordance with DIN V 4108-10 are regulated for the compliance certificates issued in accordance with this approval.

Product standard / Approval Quality: Kronotherm wood fibre insulation materials

CE marking in accordance with DIN EN 13171

General construction inspection approval: DIBt Z-23.15-1581

Quality assurance ISO 9001: QS-3281 HH

PEFC: PEFC/04-35-0010

Internal monitoring by the manufacturer as well as external monitoring by MPA NRW, Dortmund, Germany

Delivery status, characteristics

Kronotherm flex - flexible cavity insulation

Table 1: Product range

Strength [mm]	Format [mm]	Pces. per pack	Packs per pallet	Area per pack [m²]	Area per pallet [m²]	Weight per pallet [kg]
40	1350 x 575	10	10	7.76	77.63	approx. 150
50	1350 x 575	8	10	6.21	62.1	approx. 150
60	1350 x 575	6	10	4.66	46.58	approx. 140
80	1350 x 575	5	10	3.88	38.82	approx. 150
100	1350 x 575	4	10	3.11	31.05	approx. 150
120	1350 x 575	4	8	3.11	24.84	approx. 140
140	1350 x 575	3	8	2.33	18.63	approx. 130
160	1350 x 575	3	8	2.33	18.63	approx. 140
180	1350 x 575	2	10	1.55	15.53	approx. 140
200	1350 x 575	2	10	1.55	15.53	approx. 150
220	1350 x 575	2	8	1.55	12.42	approx. 140
240	1350 x 575	2	8	1.55	12.42	approx. 140

Table 2: Technical data (manufacture and monitoring as per DIN EN 13 171 and BAZ Z-23.15-1581)

Parameter	Test standard	Marking
Description	DIN EN 13171	WF – EN 13171 – T2
Nominal thermal conductivity λ_D	DIN EN 13171	0.038 W/m*K
Measuring thermal conductivity λ	DIN V 4108-4	0.039 W/m*K
Fire performance	DIN EN 13501-1	E
Building material class	DIN 4102	B 2
Gross density	EN 1602	approx. 45 kg/m²
Water vapour diffusion resistance figure µ	EN 12667	1
Specific thermal storage capacity	DIN EN ISO 10456	2100 J/kg*K
Contents		Wood fibres, binding fibres, ammonium phosphate
Waste key	EAK code	30105

Kronotherm sound – whisper board

Table 3: Product range

Thickness [mm]	Format [mm]	Pces. per pallet	Packs per pallet	Area per pack [m²]	Area per pallet [m²]	Weight per pallet [kg]
5	800 x 675	20	22	10.8	237.6	approx. 200

Table 4: Technical data
Manufacture and monitoring based on DIN EN 13 171

Parameter	Test standard	Marking
Description		Wood fibre insulation material
Nominal thermal conductivity λ_D	DIN EN 12524 (Tab. 2)	0.07 W/m^K
Gross density	EN 1602	approx. 150 kg/m^3
Impact sound reduction	DIN EN ISO 140-08	ΔL_W = 21 dB
Specific thermal storage capacity	DIN EN ISO 10456	2100 J/kg*K
Contents		Wood fibres, binding fibres, resins, ammonium phosphate
Waste key	EAK code	30105

2 Raw materials

Raw materials, primary products	**Base materials in % mass:** **Wood**, of which: - pine, in part hardwood, min. 80%, of which min. 70% with PEFC certificate
Secondary materials / Additives	Other components: - Binding fibres (BiKo) 8% - Ammonium phosphate (no data)
Material definitions	**Wood mass:** Only fresh debarked wood from pine forests harvested via thinning measures of largely PEFC-certified, ecologically-supervised forests PEFC (Programme for the Endorsement of Forest Certification Schemes) **Binding fibres:** BiKo-Fasern, Grundstoff PE **Ammonium phosphate:** Flame retardant manufactured from ammonium and phosphate. Also used in fire extinguishers and as fertiliser.
Harvesting raw materials and origin of materials	**Base material origins:** Only wood from domestic forest stocks is used. Wood with a PEFC Certificate is preferred. All of the wood originates from within a radius of max. 150 km and its regional aspect represents an essential contribution towards sustained, ecological forest management. The average transport distance is 70 km. The binding fibres, phenol resin powder and the ammonium phosphate come from a distance of 200 to 300 km.
Regional and general availability of raw materials	The wood originates exclusively from sustained managed forests and is sufficiently available as a sustained raw material. The binding fibres are manufactured from polyethylene; the ammonium phosphate is manufactured from ammonium and phosphate, i.e. from fossil raw materials of limited availability.

3 Product manufacture

Product manufacture

Manufacturing process breakdown:

1) Wood is available in the form of wood chips processed internally from raw timber.
2) Defibering the wood chips
3) Adding the ammonium phosphate as a flame retardant
4) Drying the fibres
5) Adding the binding fibres
6) Lining with preliminary fleece (independent of thickness)
7) Laying the primary fleece
8) Melting the binding fibres by means of hot air in the through-flow oven
9) Cooling the binding fibres by means of cold air in the through-flow oven
10) Trimming the panel
11) Formatting
12) Stacking and packing

All leftovers (trimmings) during the manufacturing process are redirected into the production process.

Health protection in manufacturing

Measures for avoiding health risks/problems during the manufacturing process:

Owing to the manufacturing conditions, no particular statutory or regulatory measures are required. The MAK values (Germany) are significantly fallen short of at each point of the system.

Environmental protection in manufacturing

Measures for reducing environmental pollution triggered by the manufacturing process:

Air: Waste air generated during production is cleaned in accordance with statutory specifications. Emissions are significantly below the requisite limit values.

Water/Ground: No contamination of water or ground. Waste water necessitated by production is incurred and directed and processed as process water for the manufacture of panels (at the same site).

Noise: Sound protection analyses have established that all values communicated inside and outside the production facility are far below the requisite (German) standards.

4 Product processing

Processing recommendations

Kronotherm wood fibre insulation materials can be processed using the Kronotherm knife for insulating material, electric jack saw, circular or band saws. Detailed processing information is available directly from Kronoply Heiligengrabe (Germany) or at http://www.kronoply.de.

Industrial safety Environmental protection

Industrial safety and health protection measures: Dust masks must be worn when processing/installing Kronotherm insulation materials.

Environmental protection measures: No environmental pollution is incurred by processing/installing Kronotherm insulation materials. No special measures need to be taken to protect the environment.

Residual materials

Residual materials and packaging: Residual material on building sites (cuttings, packaging) must be collected segregated by waste contingent. The specifications outlined by local disposal authorities and the information provided in section 6 “Re-use phase” must be taken into consideration when disposing of residual materials.

Packaging

Packaging Kronotherm insulation materials:

OSB, PE foils, wood and plastic bands are used for packing Kronotherm insulation materials.

5 Condition of use

Contents

Contents in condition of use:

The contents comply with those of Kronotherm wood fibre insulation materials composition (see 1. “Base materials“).

Relationships between environment and health

Health aspects:

No damage to health can be anticipated if Kronotherm wood fibre insulation materials are used as designated (see information in unit 9).

Environmental protection aspects:

No risks are anticipated for water, air and ground if Kronotherm insulation materials are used as designated (see information in unit 9).

Reliability of condition of use

Details on application experience, recommended measures for avoiding structural damage:

The areas of application indicated in the compliance certificates are valid in accordance with DIN 4108-10.

6 Extraordinary effects

Fire

Fire performance:

- Euro-class E in accordance with DIN EN 13501-1

See tests on toxicity of fire gases in section 9.5.

Water **Effects of water:** No heavy metals could be established in the quantitative analysis of inorganic trace substances in the material.

Mechanical destruction Kronotherm wood fibre insulation materials may not be subjected to mechanical stress. Damage causes a soft fracture in which the fibres are torn off inconsistently.

7 End of life phase

Re-use Provided they are untreated and undamaged, Kronotherm wood fibre insulation materials can be easily segregated and re-used for the same application when converting or completing the usage phase of a building.

Further use Provided the panels have not been damaged or contaminated with foreign products, Kronotherm insulation materials can be used again in line with their original designated purpose.

Recycling

Further use **Energetic utilisation** (in approved systems): Owing to the high heat value, energetic utilisation for generating process energy and electricity (CHP plants) from Kronotherm insulation material leftovers and Kronotherm insulation materials arising from breakage measures on the building site is recommendable.

Disposal **Disposal/Landfilling:** Kronotherm insulation material leftovers on the building site as well as those incurred by breakage measures may not be landfilled where material recycling is not possible but rather require energetic recycling (see above) or combustion in an MVA owing to their purely organic components (wood, BiKo) and their high heat values. Waste key: EWC code 030105 in accordance with the European Waste Catalogue.

Packaging: Following segregated collection, transport packaging (OSB, wood, PE foil, plastic bands) can be directed to the recycling process or also utilised energetically. In individual cases, external disposal can be arranged with the manufacturer.

8 Life cycle assessment

8.1 Manufacturing Kronotherm wood fibre insulation panels

Declared unit The declared unit refers to the manufacture and disposal of one cubic metre of wood fibre insulation board (Kronotherm flex 55 kg/m³ and Kronotherm sound 135 kg/m³; moisture: approx. 5%). The results of the life cycle assessment are outlined separately for each product.

For the end-of-life scenario, the declared unit is burned thermally in a bio-mass power plant for generating energy taking consideration of the substitution of electricity and heat.

System limits The selected system limits comprise the manufacture of Kronotherm products including the foresting processes (CO_2 absorption in the formation of wood), extraction of raw materials through to the finished packaged product at the factory gate (cradle to gate) and the end-of-life process in a bio-mass power plant:

The GaBi 4 (2006) data base was used for generating energy and transport. The review framework comprises the following details:

- Foresting processes for the provision and transport of wood (waste wood from the cleaver including chopping and transport),
- Production of all raw materials, primary products and consumables including the associated relevant transport,
- Transporting and packaging the raw materials and primary products,
- Kronotherm product production process (energy, waste, thermal utilisation of production waste, emissions) and provision of energy from the resource,
- Packaging including thermal utilisation thereof.

The products examined are exclusively produced in the German plant in Heiligengrabe.

The utilisation phase was not examined in this Declaration. As the end-of-life scenario, a bio-mass power plant with energy recovery (credits in accordance with the substitution approach) was assumed ("gate to grave"). The analysis framework starts at the gate to the utilisation plant. In terms of output, it is assumed that the ash incurred is directed to a landfill.

Cut-off criteria

On the input side, at least all material flows integrated in the system and greater than 1 % of its entire mass or contributing more than 1% to the primary energy consumption are taken into consideration. On the output side, at least all material flows are recorded which leave the system and whose environmental effects are greater than 1% of all effects in a category taken into consideration. All input used as well as all process-specific waste and process emissions have been analysed. Accordingly, the material flows with a mass share of less than 1% are also recorded. The cut-off criteria are therefore complied with as per the IBU guiding principles.

Transport

The relevant transports of raw materials and consumables used (wood, binding agents etc.) were taken into consideration.

Assumptions and estimates

On the basis of data recorded by Kronoply at the production sites, it can be assumed that the products presented are representative for the Kronotherm panels tested.

All leftovers incurred during production and final manufacturing (trimmings, cuttings and milling leftovers) are directed to thermal utilisation in a separate power plant. External thermally-utilised leftovers such as packaging material are also taken into consideration. The credits from energy decoupling of the combustion plants are incorporated in the analysis.

The end-of-life scenario was assumed as a bio-mass power plant and modelled in accordance with the average panel composition for each product.

Period under review

The data used refers to the actual production processes of fiscal 2006 of the Kronoply plant in D-16909 Heiligengrabe (Germany) where Kronoply wood fibre insulation materials are manufactured. The volumes of raw materials, energy, consumables and fuels used have been communicated as average annual values. The life cycle assessment was drawn up for Germany as a reference area.

Background data

"GaBi 4" – the software system for comprehensive analysis (/GaBi 2006/) – was used for modelling the lifecycle for the manufacture and disposal of Kronotherm insulation panels. All of the background data records of relevance for manufacturing and disposal were taken from the GaBi 4 software data base. The upstream for the forest was analysed as per "Schweinle 2001" and "Hasch 2002" in the Rüter and Albrecht update (2007).

Waste wood is taken into consideration from the waste wood dealer's gate, whereby a CO_2 content of 1.851 kg CO_2 per kg of wood dry weight and a primary energy content of 18.482 MJ per kg wood dry weight is taken into consideration. No upstream pollutants are taken into consideration; chopping the waste wood and transporting it from the waste wood dealer to the production site (25% wood moisture) are included in the analysis.

Data quality

The data for the products tested was initially recorded directly in the production facility in Heiligengrabe, Germany. The most important input and output data was supplied by Kronoply with the result that good data representativity can be assumed.

The majority of data for upstream chains originates from industrial sources and was collected under consistent time- and method-based constraints. The process data and background data used are consistent. Importance was attached to a high degree of completeness when collating material and energy flows of environmental relevance. Data was recorded by means of questionnaires.

Allocation

Allocation relates to the assignment of input and output flows for a life cycle assessment module to the product system tested (ISO 14040).

No allocations are necessary for the system of manufacturing the products under review as residual material is recycled energetically.

Allocation is necessary for the energy supply by the internal power plant at the production location. Allocation was performed in accordance with energy usage for the individual products.

The attribution of energy credits for electricity and thermal energy produced during incineration is based on the heat value of the input. The credit for thermal energy is calculated on the basis of "DE: Thermal energy from natural gas"; the credit for electricity is calculated from the German power mix. The emissions dependent on input (e.g. CO_2, HCl, SO_2 or heavy metals) were calculated in line with the content composition of the ranges used. Emissions dependent on technology (e.g. CO) are added in terms of waste gas volume.

Information on the usage phase

The usage phase and any possible extraordinary effects were not examined in the life cycle assessment. In system comparisons, lifecycle aspects must be taken into consideration depending on stress und load.

8.2 Thermal utilisation of Kronotherm insulation panels

Selecting the disposal process

Thermal utilisation in a biomass power plant was assumed for all products for this Ecological Analysis and modelled in line with the insulation panel composition for individual products. The plant features SCNR flue-gas denitrification, dry sorption for desulphurisation and a fabric filter for particle cleaning. The fuel utilisation factor is 93%.

Credits

The substitution approach is applied for generating energy. Electricity and heat as products generated are attributed the appropriate credits which would be incurred by saving fossil fuels and their emissions in the case of conventional energy generation (see Allocation above). DE: Electricity and DE: Thermal energy from natural gas (both GaBi 4, valid as at Nov. 2006) are substituted.

8.3 Depicting the analyses and evaluations

Life cycle inventory analysis

The following section depicts the life cycle inventory analysis as regards primary energy consumption, CO_2 analysis and waste volumes.

Primary energy

Table 5 depicts primary energy consumption (regenerative and non-regenerative, lower heat value H_u) broken down into total, production and end of life of one cubic metre of wood fibre insulation panel Kronotherm sound and Kronotherm flex.

Table 5: Primary energy consumption for the manufacture of 1 cubic metre of wood fibre insulation material

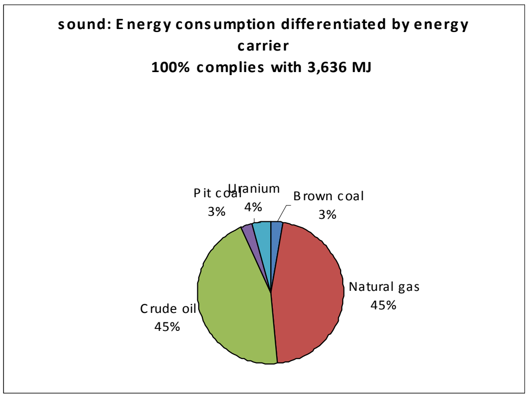
KRONOTHERM sound panel product mix per m³				
Assessment factor	Unit per m³	Total	Production	End of Life
Non-regenerative primary energy	[MJ]	-54.95	3,636	-3,691
Regenerative primary energy	[MJ]	3,149	3,190	-40.91
KRONOTHERM flex panel product mix per m³				
Assessment factor	Unit per m³	Total	Production	End of Life
Non-regenerative primary energy	[MJ]	3.15	918	-915
Regenerative primary energy	[MJ]	970	980	-10.16

Consumption of non-regenerative energy for the manufacture of insulation panels accounts for approx. 918-3,636 MJ per m^3 (depending on the panel type indicated in Table 5), whereby production accounts for approx. 30-45.5%, provision of raw materials accounts for 49.1-68.5%, transport accounts for 0.8-1.3% and packaging accounts for 1.1-4.4%.

980-3,190 MJ of regenerative energies (99.5% solar energy stored in the biomass and 0.5% wind and water power) are also used for manufacturing one cubic metre of insulation panel.

Closer inspection of the composition of regenerative primary energy consumption indicates that the energy stored in the insulation panel product primarily in the renewable raw materials within the throes of the photosynthesis process stays until its end of life. 1 cubic metre of finished insulation panel has a lower heat value of approx. 3,066 MJ/m³ for Kronotherm sound and 763 MJ/m³ for Kronotherm flex.

Closer analysis of the non-regenerative energy requirements for the manufacture of a cubic metre of insulation board (Fig. 1) indicates that the essential primary energy carrier is natural gas accounting for approx. 45-58% of the primary energy used, followed by crude oil (32-45%). The rest is accounted for by pit coal and brown coal deposits as well as uranium (power mix in the upstream energy supply).



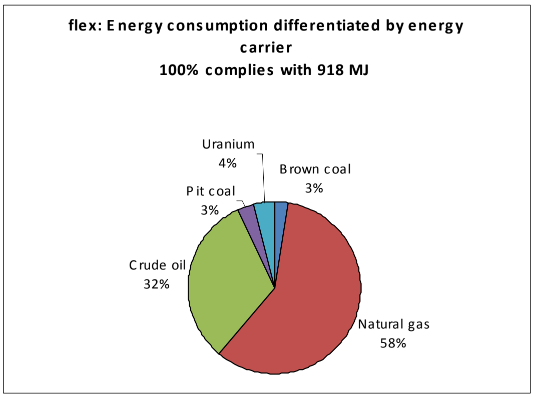


Fig. 1: Distribution of non-regenerative energy consumption by energy carrier in the manufacture of 1 m³ of wood fibre insulation panel, type Kronotherm sound and flex, in %.

Fig. 2 further depicts the non-regenerative energy consumption of the manufacturing chain. Natural gas is primarily used as a non-regenerative energy carrier at the production location. Production waste and biomass are still used in the energy supply used in the company's own power plant for the production of electricity and thermal energy. Thermal utilisation of packaging is modelled as average waste incineration in Germany with steam conversion and electricity production. This gives rise to electricity credits by substituting electricity in the public network in line with the German power mix and a steam credit in accordance with average production of steam from natural gas in Germany for thermal utilisation of packaging.

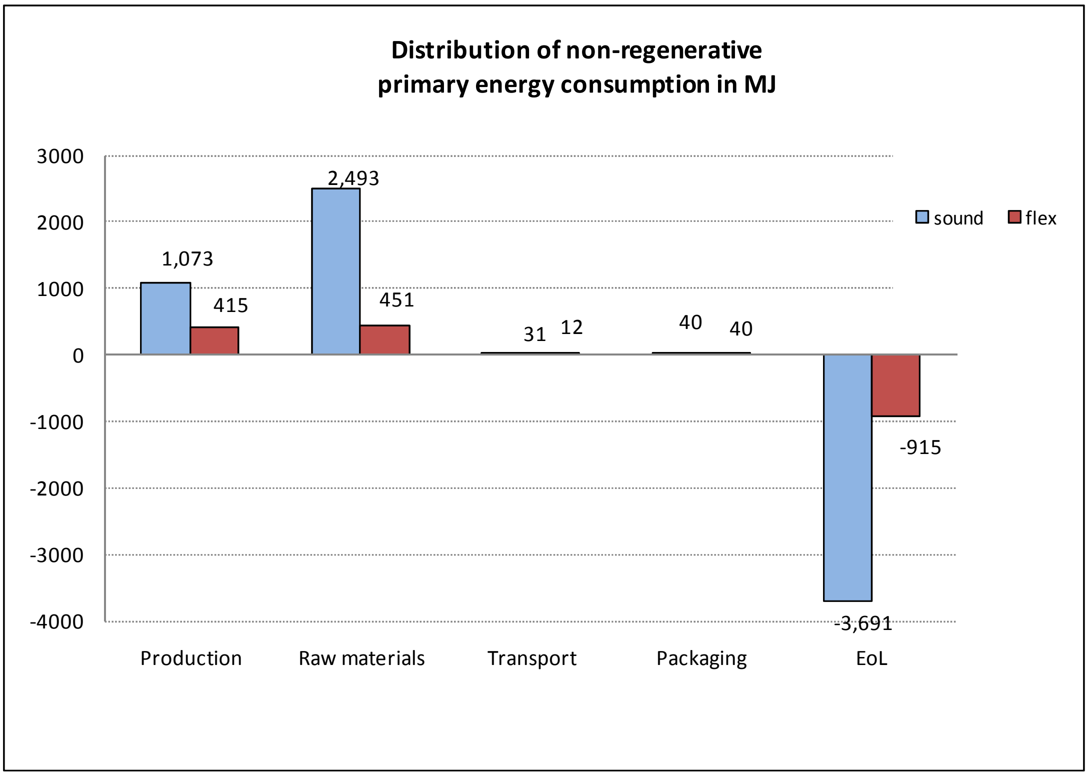
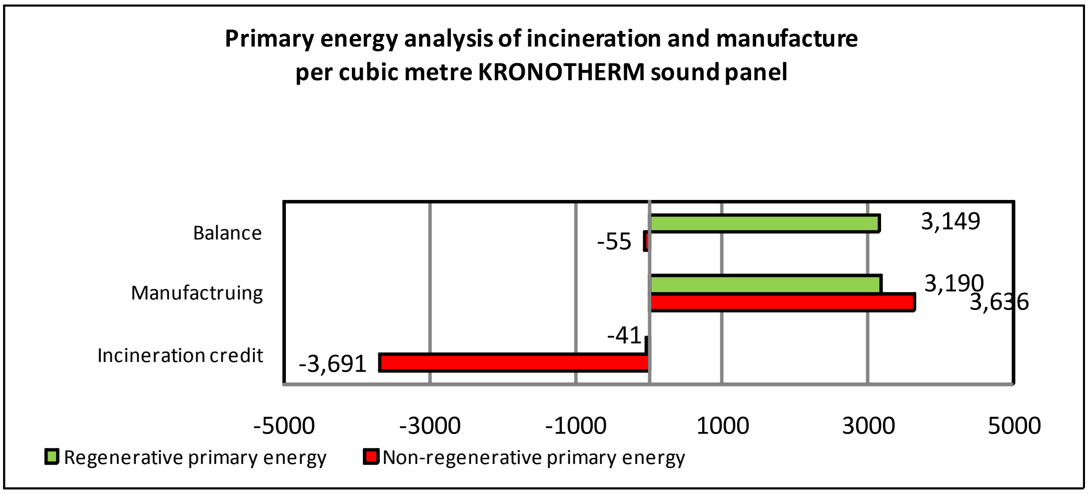


Fig. 2: Distribution of non-regenerative energy consumption in the manufacture of one cubic metre of wood fibre insulation panel, type Kronotherm sound and flex, in MJ (EoL = End of Life)

Taking consideration of manufacturing and End of Life (combustion of the insulation panel in a biomass power plant) gives rise to an energy credit following substitution of electricity and steam (credit for the German power mix and steam from natural gas) of 915-3.691 MJ non-regenerative energy carrier per m^3 of insulation panel, depending on the panel type (Fig. 3, Combustion credit for each panel type). This reduces the use of non-regenerative primary energy when offsetting manufacture and incineration, whereby the regenerative energy stored in the product is used.



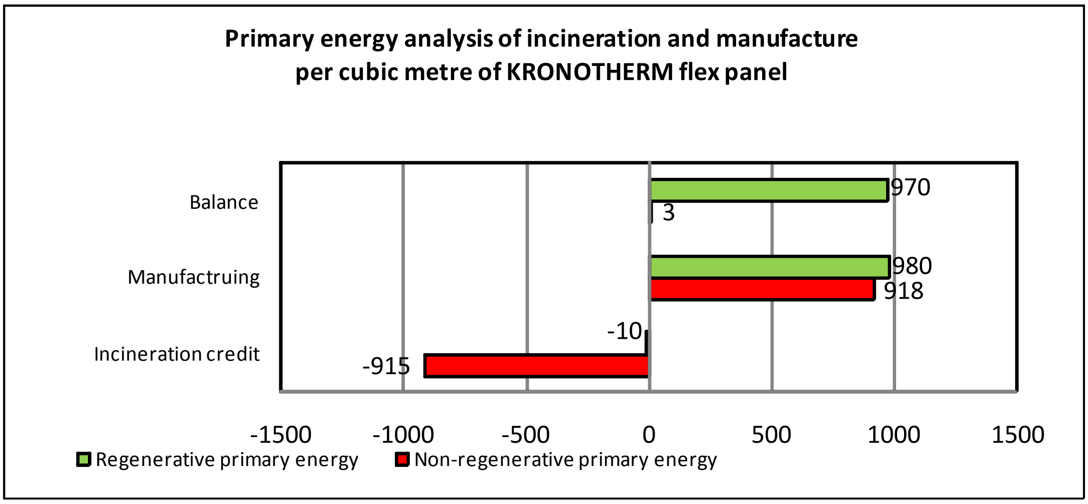
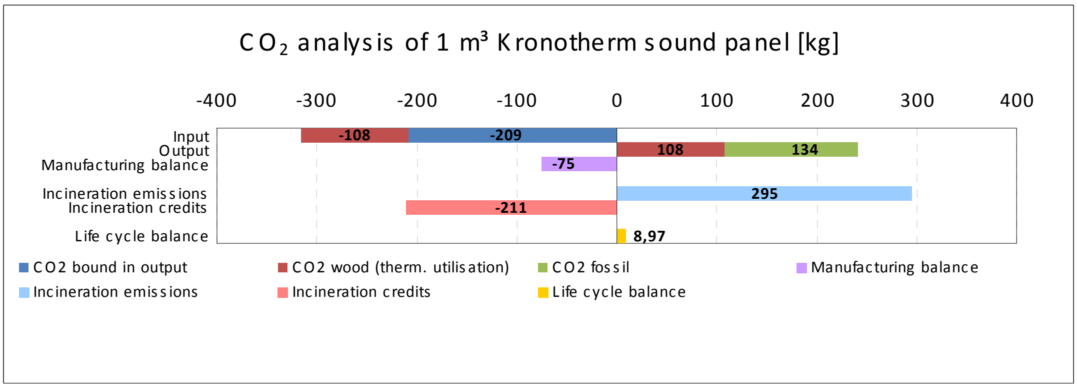


Fig. 3: **Primary energy analysis of regenerative and non-regenerative energy carriers for the manufacture and incineration of 1 m³ of each of the 4 insulation panel types**

CO_2 analysis

Fig. 4 below depicts the CO_2 analysis for each panel type.



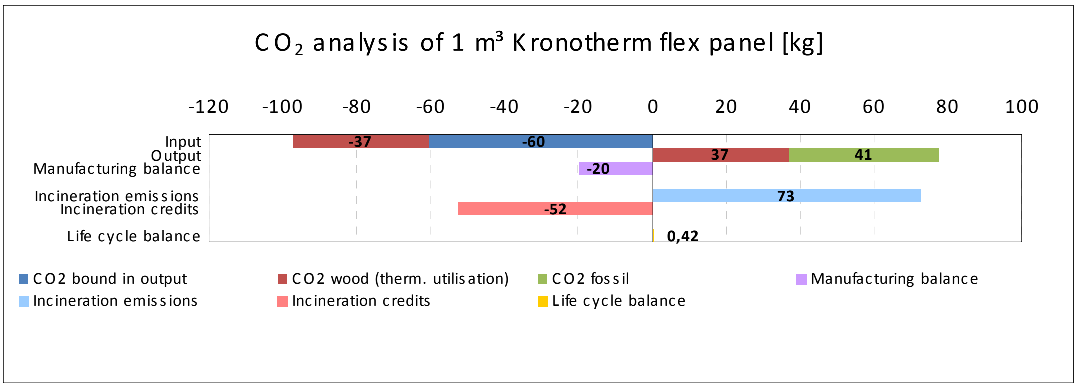


Fig. 4: CO_2 analysis of the manufacture of 1 m³ insulation panel

The CO_2 analysis in Fig. 4 indicates that the manufacture of one cubic metre each of Kronotherm sound/flex causes approx. 242/78 kg of CO_2 emissions, of which approx. 108/37 kg of CO_2 come from direct thermal utilisation of wood and 134/41 kg of CO_2 is attributable to fossil emissions from production and upstream processes. On the other hand, a total of 317/97 kg of CO_2 are stored from the air via photosynthesis in the wood following the manufacture of each cubic metre of insulation panel over the course of tree growth, of which 209/60 kg of CO_2 remains bound in the wood per cubic metre over the utilisation period. The CO_2 stored in the insulation panel is not released until the end of the life cycle, e.g. during thermal utilisation of the insulation panel. If CO_2 absorption (Input) is offset against CO_2 emissions (Output) in manufacturing, the result is a balance of -75/-20 kg of stored CO_2 per m³ of insulation panel for the manufacturing phase (Manufacturing) by means of binding in the product and substitution of non-regenerative energy carriers. Combined with the emissions and credits associated with incineration, this gives rise to a balance for the entire lifecycle of 8.97/0.42 kg CO_2 per m³ of insulation panel (Lifecycle).

Waste

An analysis of waste volumes for the manufacture of 1 m^3 insulation panel is depicted separately for the three segments: mining waste / excavation waste (including ore treatment residue), municipal solid waste (including domestic waste and commercial waste) and special waste including radioactive waste (Table 6). Mining waste forms by far the most significant quantitative share, followed by special waste and municipal solid waste.

Table 6: Waste volume in the manufacture and incineration (End of Life) of 1 m³ insulation board

Waste [kg / m^3 sound panel]			
Assessment factor	**Manufacture**	**End of Life**	**Total**
Landfilling / Excavated waste	134.76	-291.29	-156.53
Municipal solid waste	0.00	0.00	0.00
Special waste	0.60	-0.11	0.48
of which radioactive waste	0.05	-0.11	-0.06
Waste [kg / m^3 flex panel]			
Assessment factor	**Manufacture**	**End of Life**	**Total**
Landfilling / Excavated waste	117.90	-72.51	45.39
Municipal solid waste	0.00	0.00	0.00
Special waste	0.39	-0.03	0.36
of which radioactive waste	0.01	-0.03	-0.02

As far as **excavated waste** is concerned, mining waste accounts for the most significant quantitative factor in manufacturing with over 95%, followed by ore treatment residue deposits, building rubble, excavated earth, ash etc. with a total share of around 5%. Mining waste is incurred in particular in the extraction of mineral raw materials and coal in the provision of raw materials and energy carriers. Incineration of the insulation panel at the end of the lifecycle substitutes waste (excavated waste) in the provision of energy to an extent of approx. 72-291 kg per m^3 of insulation panel.

Essential influential factors within the **municipal solid waste** segment are unspecific waste (20-90%) for Kronotherm sound and Kronotherm flex and around 70% commercial waste similar to domestic waste for Kronotherm sound.

Special waste is essentially sludge (0-44%) and special waste stored underground (52-92%).

Estimated impact

Table 7 below depicts the absolute contributions by manufacturing and incineration of 1 m^3 insulation panel to the Greenhouse Warming Potential (GWP 100), Ozone Depletion Potential (ODP), Acid Potential (AP), Eutrification Potential (EP) and Photochemical Ozone Creation Potential (summer smog potential POCP) effect categories. The regenerative primary energy (PE reg.) and non-regenerative primary energy (PE ne) factors are also outlined.

Table 11: Contributions by manufacturing and end of life per cubic metre of insulation panel to the effect categories under review

	PE ne	PE reg.	GWP 100	ODP	AP	EP	POCP
Unit	**MJ**	**MJ**	**kg CO_2 equiv.**	**kg R11 equiv.**	**kg SO_2 equiv.**	**kg PO_4 equiv.**	**kg C_2H_4 equiv.**
KRONOTHERM sound							
Manufacture	**3,636.3**	**3,189.6**	**-62.8**	**4.23E-06**	**4.11E-01**	**5.08E-02**	**5.07E-02**
End of life	**-3,691.3**	**-40.9**	**70.5**	**-8.59E-06**	**-1.46E-02**	**-2.25E-02**	**-1.78E-02**
Total	**-55.0**	**3,148.7**	**7.8**	**-4.36E-06**	**2.65E-01**	**2.83E-02**	**3.92E-02**
KRONOTHERM flex							
Manufacture	**918.2**	**980.2**	**-15.9**	**1.03E-06**	**1.55E-01**	**1.71E-02**	**1.42E-02**
End of life	**-915.1**	**-10.2**	**16.8**	**-2.13E-06**	**-2.50E-02**	**-4.07E-03**	**-4.02E-03**
Total	**3.1**	**970.0**	**0.9**	**-1.10E-06**	**1.30E-01**	**1.30E-02**	**1.02E-02**

If the **system limit manufacturing including the end of life** in a biomass plant is taken into consideration, the significance of the type of utilisation and/or disposal over the entire lifecycle becomes apparent from an environmental aspect. The additional emissions incurred as a result and/or any associated substitution effects in the energy supply system are depicted graphically for the four different panel types in Fig. 5.

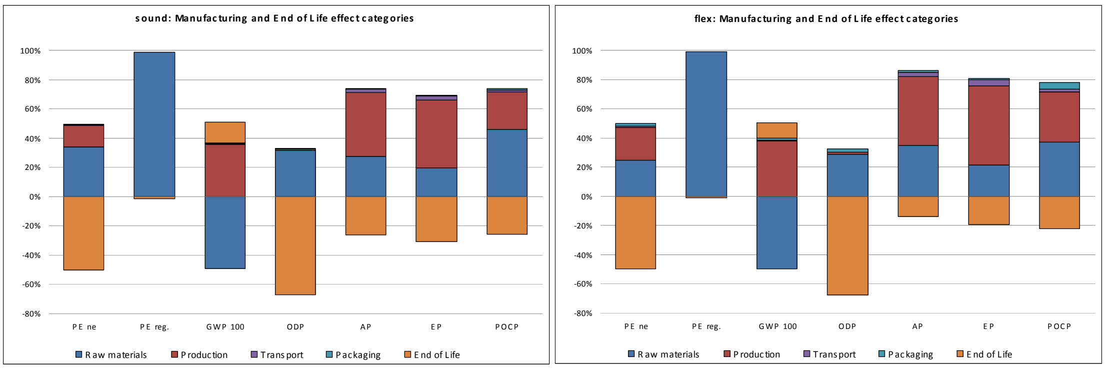


Fig. 5: Process shares in the effect categories – system limit plant gate and incineration of the insulation panel at the end of life

The end of life depicted arises by offsetting the emissions produced in the incineration process against the emissions avoided for generating electricity and steam. This involves the difference between the emissions of insulation panel incineration and the emissions avoided as a result in average German energy generation (credits). These increased emissions arise in the incineration of the insulation panel in the biomass power plant assumed. If the insulation panel is incinerated in more efficient plants, these increased emissions can be reduced by additional energetic substitution effects. If incineration is performed in less efficient plants, the share of the end of life process in overall emissions increases accordingly.

The **Global Warming Potential** is dominated by carbon dioxide in manufacturing. For each cubic metre of insulation panel, 60-209 kg of CO_2 (depending on the panel type analysed) are integrated in the insulation panel and another 37-177 kg of CO_2 are integrated in the biomass used for energy recovery. This CO_2 integration in the tree growth phase is offset by

CO_2 emissions in the provision of raw materials, production, transport and packaging. Around 95% of the emissions are carbon dioxide, approx. 4% are VOC emissions, especially methane and nitrous oxide. With the plant gate system limit, this gives rise to a Global Warming Potential of -62.8/-15.9 kg of CO_2 equivalent for Kronotherm sound/flex. At the End of Life, a balance from the credits and greenhouse gases emitted gives rise to a value of 70.5/16.8 kg of CO_2 equivalent for Kronotherm sound/flex. Over the product lifecycle taking consideration of the End of Life, this gives rise to a Global Warming Potential of 7.8/0.9 kg of CO_2 equivalent for Kronotherm sound/flex.

The provision of raw materials (approx. 90-95.5%) represents the primary contribution to the **Ozone Depletion Potential** during the production phase. For each m³ of Kronotherm sound/flex insulation panel, a total Ozone Depletion Potential of 4.23E-06/1.03E-06 kg of R11 equiv. is incurred in production. The substitution of electricity at End of Life, which is higher than production emissions, causes a negative Ozone Depletion Potential value of approx. 4.36E-06/1.01E-06 kg of R11 equiv. in the system as a whole.

The provision of raw materials (around 42-47%) and production (around 48-53%) in particular contribute towards the **Acidification Potential**. Per m³ of Kronotherm sound/flex, 0.411/0.155 kg of SO_2 equivalent are emitted during the production phase. The Acidification Potential is lowered by substitution effects at the End of Life. This gives rise to an Acidification Potential in the system under review of approx. 0.265/0.130 kg of SO_2 equivalent per cubic metre of Kronotherm sound.

The provision of raw materials (26-28%) and production (about 67%) to the plant gate system limit are the most significant contributing factors in terms of the **Eutrophication Potential**. In manufacturing, the Eutrophication Potential accounts for 0.0508/0.0171 kg of phosphate equivalent. The EoL increases the Eutrophication Potential taking consideration of the substitution effects of incineration to another 0.0283/0.0130 kg of phosphate equivalent.

The provision of raw materials contributes approx. 45-60% and production contributes 35-45% to the **Photochemical Oxone Creation Potential (near-ground ozone formation)**. Overall, the POCP within the plant gate system limit accounts for an ethene equivalent of 0.051/0.143 kg. The EoL reduces the POCP by means of energy substitution to 0.033/0.010 kg of ethene equivalent.

9 Requisite evidence

9.1 Formaldehyde

Measuring agency: HFB Engineering GmbH, Prüfstelle für Baustoffe und Bauelemente, Leipzig, Germany

Test reports, date: 31100 1737 / 1/ 08 and 31100 1737 / 2/ 08 on 12.8.2008

Result: The formaldehyde content was examined using the Perforator Method in accordance with DIN EN 120. The results are clearly below the limit value of 8.0 mg HCHO/100g atro panel (at 6.5% material moisture) in accordance with DIBt Guideline 100 in line with the Chemical Restriction Regulation, Annexe to § 1, section 3 in combination with the publication by the BGA in the Public Health Gazette in October 1991 on “Test procedures for wood materials”. The average results for Kronotherm flex wood fibre insulation panels with a nominal thickness of 100 mm are 0.34 mg HCHO/100g and 0.32 mg for Kronotherm hardboard in accordance with DIN EN 120 (average values of double determination).

9.2 MDI

MDI is not used in the production of Kronotherm products and is therefore not documented.

9.3 Testing pre-treatment of substances used

No waste wood is used for Kronotherm wood fibre insulation materials.

9.4 Eluate analysis

Measuring agency: Elektro-Physik Aachen GmbH

Test report: 7002/2009 dated 27.5.2009 and 7007/2009 dated 5.8.2009

Result: "Kronotherm flex" and "Kronotherm sound" were tested. The parameters were determined in accordance with the "Waste Wood Act 08/2002". The requirements of the Waste Wood Act are complied with for all of the parameters.

9.5 Toxicity of fire gases

Measuring agency: Elektro-Physik Aachen GmbH

Test report: 12/2009 dated 14.05.09

Result: "Kronotherm flex" was tested. The results in accordance with DIN 53 436 indicate that no chlorine or sulphur compounds could be verified unlike CO, CO_2, hydrogen cyanide and COHb. The gaseous emissions released under the selected test conditions do not comply with the emissions released by wood under the same conditions.

Measuring agency: Elektro-Physik Aachen GmbH

Test report: 23/2009 dated 28.07.09

Result: "Kronotherm sound" was tested. The results in accordance with DIN 53 436 indicate that no chlorine or sulphur compounds could be verified. The concentration of hydrocyanic acid complies with the concentration emitted by wood under the same conditions. The gaseous emissions released under the selected test conditions largely comply with the emissions released by wood under the same conditions.

9.6 VOC

Volatile organic compounds (VOC) can be indicated as an option where validity is shorter (1 year).

9.7 PCP / Lindan

Measuring agency: WKI Fraunhofer Wilhelm-Klauditz-Institut, Prüf-, Überwachungs- und Zertifizierungsstelle, Braunschweig, Germany

Test report: B 3196 / 2008, 25.8. – 28.8.2008 [as per PA-C-12:2006-02 "Determining penta-chlorphenol (PCP) and γ-hexachlorocyclohexane (Lindan) in wood and wood materials"]

Result: After extraction of the substances contained, the solutions were derivatised, reprocessed and subjected to a gas chromatography analysis. The PCP and Lindan values are below the limit of detection of 0.1 mg/kg.

10 PCR document and examination

This Declaration is based on the "Wooden materials" PCR document, version dated January 2009.

Review of the PCR document by the Expert Committee. Chairman of the Expert Committee: Prof. Dr.-Ing. Hans-Wolf Reinhardt (University of Stuttgart, IWB)
Independent examination of the Declaration in accordance with ISO 14025: ☐ internal ☒ external
Validation of the Declaration: Dr. Frank Werner

11 Literature

/Hasch 2002/ **J. Hasch:** Ökologische Betrachtungen von Holzspan- und Holzfaserplatten (Ecological Analysis of Chipboard and Wood Fibreboard). Thesis, Hamburg, 2002 – revised in 2007: Rueter, S. (BFH HAMBURG; Wood Technology), Albrecht, S. (Uni Stuttgart, GaBi)

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STANDARDS AND LEGISLATION

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DIN EN ISO 14040 DIN EN ISO 14040:2006-10, Environmental management – Life cycle assessment – Principles and framework (ISO 14040:2006); German and English versions EN ISO 14040:2006

DIN EN ISO 14041 DIN EN ISO 14044:2006-10, Environmental management – Life cycle assessment – Principles and framework (ISO 14044:2006); German and English versions EN ISO 14044:2006

DIN EN ISO 14044 DIN EN ISO 14044:2006-10, Environmental management – Life cycle assessment – Requirements and guidelines (ISO 14044:2006); German and English versions EN ISO 14044:2006

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DIN EN 826	DIN EN 826:1996-05, Thermal insulating products for building applications – Determination of compression behaviour; German version EN 826:1996
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DIN V 4108-4	DIN V 4108-4: 2007-04, Thermal insulation and energy economy in buildings – Part 4: Hygrothermal design values
DIN 4108-10	DIN 4108-10:2008-06, Thermal insulation and energy economy in buildings – Part 10: Application-related requirements for thermal insulation materials- factory-made products
DIN EN 13501-1	DIN EN 13501-1:2007-05, Fire classification of construction products and building elements – Part 1: Classification using data from reaction to fire tests; German version EN 13501-1:2007
BAZ Z-23.15-1581	Wood fibre (WF) thermal insulation elements in accordance with DIN EN 13171:2001-10 as per list in Annex 1

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