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IndiNature: IndiTherm®

Product LCA

IndiTherm® Product LCA	Project number	11454
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	Author	Ruth Saint
	Checked by	Lexy Fletcher

Contents

1.0 General Information

Product name: IndiTherm®.

Type of assessment: Cradle to grave, as per BS EN 15804 (2012+A2:2019).

Declared product / unit: 1 m³ IndiTherm® industrial hemp fibre insulation batt.

Range of validity: This product LCA covers the production of IndiTherm®, manufactured by Industrial Nature UK Ltd (IndiNature) at: IndiNature Mill, Oxnam Rd, Jedburgh, Scottish Borders, TD8 6NN using the national average energy mix.

2.0 Product

2.1 General product description and application

The product under consideration is IndiTherm® industrial hemp fibre insulation batt. Vapour breathable flexible insulation batts made with UK industrial hemp, with sodium carbonate as a fire protection agent and low melting polymer as a binder.

The insulation batt is used for friction fit between structural framing or against masonry - with excellent rigidity to resist slumping. Soft to touch for installers with exceptional thermal and moisture buffering properties. It has the added property of low density heat storage, which means indoor temperatures stay warm in winter and cool in summer. Durability tested.

2.2 Technical data

The below shows relevant (construction related) technical data for the declared product.

Thermal Conductivity λ	0.040 W/m.K
Bulk Density ρ	45 kg/m³
Specific Heat Capacity C	2100 J/(kgK)
Vapour Diffusion Resistance μ	1.3
Sound Reduction	Min 40dB (50mm+)
Reaction to Fire	E - BS EN 13501-1:2018 PASS

Available formats that were used to calculate the impacts on a cubic meter basis:

Dimensions (mm)	Thicknesses (mm)
370 x 1200	50, 80, 100, 140 mm
440 x 1200	50, 80, 100, 140 mm
570 x 1200	50, 80, 100, 140 mm

2.3 Constituent materials

The declared product consists of natural fibres (industrial hemp), which are partly impregnated with sodium carbonate as a fire retardant. Polymer fibres are also added as a binder. The table below outlines the material quantities, by % mass, in the functional unit.

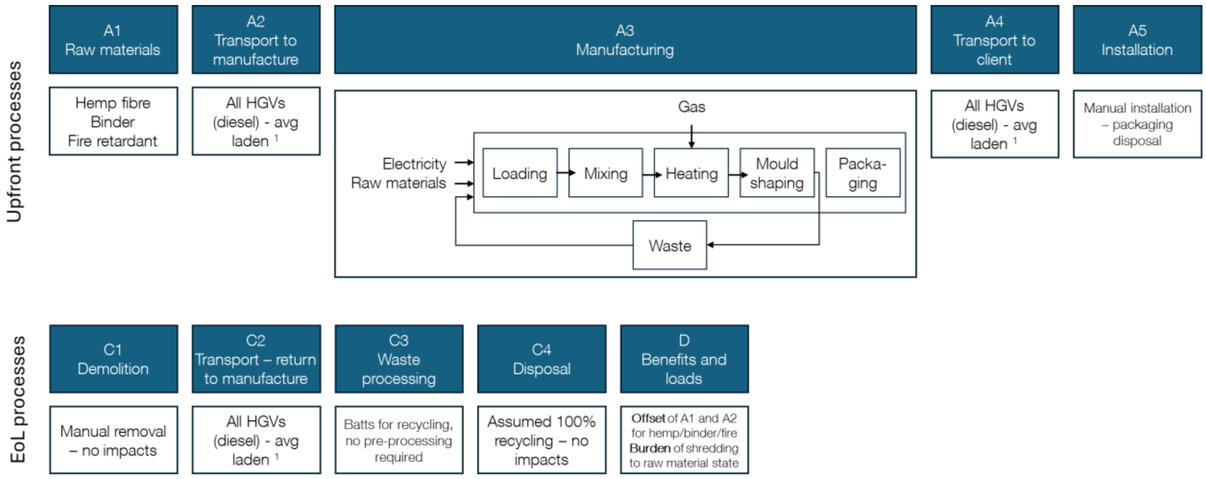
Component	Function	Mass (%)
Hemp fibre [1]	Insulation material	90%

Low melting polymer [2]	Binder	9%
Sodium carbonate [3]	Fire retardant	<1%

[1] Obtained from industrial hemp, sourced from East Yorkshire Hemp.
[2] Polyester fibres based on PET which are manufactured in South Korea.
[3] A salt, also known as soda ash.

2.4 Manufacturing

The hemp fibre is sourced from a local UK company, East Yorkshire Hemp, the sodium carbonate comes from a manufacturer in Leeds and the binder is manufactured and transported from Seoul, South Korea. The system diagram for the cradle to grave assessment is presented below.



2.5 Packaging

The IndiTherm® product is distributed in packs of batts, ranging from four to eight batts per pack (depending on dimensions). The packaging used is LDPE film, supplied by Polystar Packaging, in Southampton, UK, with an average of 7.9 linear meters required per cubic meter of product. The dimensions of the film are 1150 mm wide and 40 microns thick. This film is considered to be single use and is removed during the installation stage and subsequently disposed of, assumed to be landfilled.

2.6 Delivery and transport

The IndiTherm® batts are delivered in packs, ranging from four to eight batts per pack depending on the batt thickness. 50 mm thick batts are delivered in packs of eight, 80 mm thick batts are delivered in packs of five, and 100 and 140 mm thick batts are delivered in packs of four.

The product is assumed to be delivered by HGV truck (diesel) under average laden conditions, using data from the Department for Energy Security and Net Zero[1]. The transport distance is assumed to be within a 300 km radius, with a weight of 45.34 kg per declared unit (m^3), including packaging.

2.7 Processing / installation

[1] https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2023

Installation is done manually, and the batts can be cut to size. Detailed information on the installation process can be found in the technical product data sheet.

2.8 Use stage

In the case of insulating materials made from renewable raw materials, there are no changes in the material composition over the period of use provided that the planning is carried out properly, the installation is carried out properly and professionally and the use is trouble free.

2.9 Reference Service Life (RSL)

There is no reference service life according to the rules of EN 15804+A2 (Annex A) and no default value from complementary PCR. However, the actual service life is assumed to be equal to the building's service life (60 years using RICS default).

2.10 Re use, recycling and disposal

As IndiNature was founded in 2016, the insulation materials under consideration have not been installed for a full RSL yet, which means there is therefore no experience yet with the disposal of the product. However, according to the manufacturer, recycling as a secondary raw material for the production of new insulation mats is currently carried out for waste offcuts at the manufacture site so a product take back scheme for recycling is feasible.

As soft plastics are not commonly recycled in the UK at present (though this is a growing market), disposal via landfill is assumed for the LDPE film packaging.

2.11 Further information

Further information on the declared product can be found online at https://www.indinature.co/inditherm.

3.0 LCA Calculation Rules

3.1 Declared / functional unit

The declared unit according to PCR-B for renewable insulation materials is one cubic metre of insulation material (1 m^3). The declared insulation batts have different dimensions but the relative material composition does not change and therefore has no influence on the results of the life cycle assessment (per m^3). The following table shows the average gross density for conversion to one kg.

Name	Value	Unit
Declared unit	1	m^3
Gross density	45	kg/m^3

3.2 System boundary

This assessment refers to a cradle to grave product LCA and Module D (Modules A+B+C+D). All modules contained in the following table have been declared (X) or marked as not required (MNR) were appropriate.

Product stage			Construction stage		Use stage							End of Life (EoL) stage				Benefits and loads
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Raw material supply	Transport	Manufacturing	Transport	Construction / installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Demolition	Transport	Waste processing	Disposal	Potential for reuse, recovery and recycling
X	X	X	X	X	MNR	MNR	MNR	MNR	MNR	MNR	MNR	X	X	X	X	X

A1-A3:

The product stage comprises the production of the insulation batts including the corresponding upstream supply chains of the components, ie the cultivation of hemp as well as the production of the hemp fibres, the production of the polymer binder as well as the extraction and processing of sodium carbonate. In addition, the transport of these input materials to the production plant and the disposal of the waste arising during production are included.

Embodied energy content and biogenic carbon are considered as material properties. For the assessment, the carbon contained in the renewable raw materials (ie hemp) was calculated as a negative input upon entering the system and is reported separately.

The energy (electricity and gas) required to transform the input materials into the output IndiTherm® product is converted into the carbon dioxide equivalent (CO_2e) using data from the Department for Energy Security and Net Zero[1] and captured under Stage A3.

A4-A5:

A4 represents the transport of the insulation material for installation. Details are presented in Section 4.2. A5 includes the installation of the product. This also includes the disposal of packaging waste.

B1-B7:

Stages B1 Use, B2 Maintenance and B3 Repair are not relevant for this product group. Stage B4 Replacement is equivalent to the end of product life. There are no material and energy flows when the product is removed. Stages B5 Refurbishment, B6 Energy Use and B7 Water use are not applicable at insulation level.

C1 - C4 and D:

For the end of life (EoL) stage, a scenario with 100% closed loop recycling is considered, ie all of the installed product is collected at EoL and fed back into the initial product system. The environmental impact of waste processing is declared in C3. However, as no waste processing or sorting is required the only impacts here are the release of the sequestered biogenic carbon.

The benefits and loads associated with the recycling of the product are declared in Module D. Some post EoL processing is required to transform the recycled material back into a raw material, ie shredding, and this burden is captured in Module D. The benefits are due to offsetting the production and transport of virgin hemp fibres (A1 and A2). The biogenic carbon that is stored in the recycled hemp fibres can be accredited to the subsequent product life cycle but is not reported under Module D.

3.3 Estimations and assumptions

The following assumptions were made in the assessment:

- The biogenic carbon content of the hemp fibre was derived from various sources and the data behind the value used (1.45 $kgCO_2/kg$) can be found in the accompanying spreadsheet
- In lieu of primary data for Stage A4 (eg data on annual average distances to client), an assumed average value of 300 km was used
- It is assumed that any transport by road (A2, A4, C2) is via HGV and the data from the Department for Energy Security and Net Zero[1] for average HGV, average laden was used as a conservative assumption. Any transport by sea (assumed for delivery of the binder from Seoul) is assumed to be average container ship, using data from the Department for Energy Security and Net Zero[1]
- The transport distance to landfill for the packaging was assumed to be 50 km.

3.4 Background data

The background data are taken from various sources, primarily EPDs and from the Department for Energy Security and Net Zero[1]. The data for the production of the hemp fibres was derived from a MSc thesis that studied the IndiTherm® product system specifically. All calculations and data sources are detailed in the accompanying spreadsheet.

3.5 Data quality

The foreground data was collected using a data collection form adapted for the company IndiNature and the declared product, derived from the EPD data collection template from BRE. Queries were clarified in an iterative process in writing via email or in web meetings. A virtual tour of the manufacturing facility enabled the completeness and plausibility of the manufacturer's data to be checked. Due to short term nature of this project, the sample size for the manufacturing energy (A3) consumption is small, however, it can be deemed reflective of a conservative scenario as the company is still scaling production.

A consistent and uniform calculation procedure according to ISO 14044 was used. In the absence of material specific data, proxy data sets were used. When selecting the background data, attention was paid to the technological, geographical and time related representativeness of the data basis. The EPDs used for the binder and fire retardant were valid, ie less than five years old.

3.6 Reporting period

The data provided by the manufacturer refer to the period 6 March 2024 to 1 April 2024 due to the short term nature of this project. However, IndiNature are implementing a data capture approach for long term reporting to enable more accurate LCAs in the future.

3.7 Allocation

In the supply chain: The upstream processes in the supply chain (A1-A3) are represented by using EPDs for the binder, fire retardant and packaging and a MSc thesis that used primary data for IndiTherm's® specific product system. In principle, allocation rules in the background data can be found in the respective data set documentation. In the process chain for hemp fibres, a mass allocation between the products fibres, shives and dust was carried out in the MSc thesis. 28% of the loads were assigned to the fibres. Additionally, a recycled content of

5% was used based on the manufacturer's information, so 95% of the hemp's primary production impacts were accounted for, with 5% entering the product system burden free.

In the primary data regarding different products: In addition to the declared product, other insulation products are also produced at the IndiNature manufacture site. However, during the reference period only the days were IndiTherm® batts were manufactured were included in the consumption figures. R&D was conducted on a couple of days within the reference period but this data has been marked as anomalous and used to generate a conservative A3 value.

In the primary data regarding by-products: by-products here refer to the waste generated during the production (A1-A3) of the insulation batts, which is directly fed back into the product system. An allocation of 5% recycled content is applied, as described above.

With regard to recycling the following must be stated: All benefits for recycling the product itself were allocated to Module D.

3.8 Comparability

In principle, a comparison or evaluation of product level LCA data is only possible if all data sets to be compared have been created in accordance with EN 15804, the same programme specific PCR / any additional rules and the same background database have been used, and the building context / product specific performance characteristics are also taken into account.

4.0 LCA Scenarios

4.1 A1-A3 Product stage

According to BS EN 15804, no technical scenario information is required for Modules A1-A3 because the assessment of these modules is the responsibility of the manufacturer and may not be changed by the user of the life cycle assessment.

However, based on the A3 energy consumption data provided by the client, three scenarios were generated:

- Average – data excluding the anomalies from R&D days (12 days' worth of data)
- Conservative – all data including anomalies from R&D days (14 days' worth of data)
- High output – only data associated with a daily output of >40 m^3 product (seven days' worth of data)

4.2 A4-A5 Construction stage

The A4 transport scenario to the client / building site is shown below. In lieu of primary data for A4 (eg data on annual average distances to client), an assumed average value of 300 km was used.

Parameters to describe the transport to the building site (A4)	Value
Average transport distance	300 km
Vehicle type (Department for Energy Security and Net Zero)	All HGV
Fuel type	Diesel
Average capacity utilisation (including empty returns)	Average laden
Average gross density of transported products	45.34 kg/m^3

The A5 impacts only refer to the disposal of the packaging (assumed 50 km to landfill for 0.34 kg per declared unit) as there are no auxiliary materials or tools required for installation. Water, electricity or other resource use is also not required.

4.3 B1-B7 Use stage

Service life: 60 years.

In the use stage (B1), no material and energy flows relevant for the LCA take place for insulation materials made from renewable raw materials. During use, no maintenance, repair, replacement or conversion processes take place for insulating materials made from renewable raw materials, which is why Modules B2 to B5 do not cause any environmental impact. Modules B6 and B7 are not relevant for insulating materials made from renewable raw materials, which also means that no environmental impact is caused. In Modules B1-B7 there are therefore no material or mass flows.

4.4 C1-C4 EoL stage

No material and energy flows take place during demolition because it is assumed that the insulation is removed manually, in the same way as during installation. As a disposal scenario, the recycling of the insulation material in the same facility as the manufacture was chosen (C3) because it is assumed feasible and realistic due to the current processing of offcuts during manufacture. The transport back to the manufacturing facility (C2) was assumed to be the same as A4, 300 km.

4.5 D Reuse, recovery, recycling potential

The entire material (excluding packaging which is sent to landfill) is recycled, there is no direct reuse and / or thermal recycling (incineration). The virgin material offset through recycling in the initial manufacturing site is declared as a benefit in Module D.

5.0 LCA Results

The following table contains the LCA results for a declared unit of 1m³ of IndiTherm® insulation batt with a density of 45 kg/m³.

Scenario	Unit	A1	A2	A3	**A1-A3**	A4	A5	C1	C2	C3	C4	D
Average A3	$kgCO_2e/m^3$	11.96	3.26	8.24	**23.49**	1.64	0.04	0	1.63		0	-5.6
Biogenic carbon	$kgCO_2/m^3$	-58.82								58.82		

Considering the three A3 scenarios – average, conservative, and high output – the impact of Stage A3 can range from 5.8 to 11.6 $kgCO_2e/m^3$. Thus, the A1-A3 impacts range from 21.09 to 26.84 $kgCO_2e/m^3$.

The following table contains the LCA results for a declared unit as above, but normalised per kg of material.

Scenario	Unit	A1	A2	A3	**A1-A3**	A4	A5	C1	C2	C3	C4	D
Average A3	$kgCO_2e/kg$	0.27	0.07	0.18	**0.52**	0.04	0.001	0	0.04		0	-0.12
Biogenic carbon	$kgCO_2/kg$	-1.31								1.31		

Considering the three A3 scenarios – average, conservative, and high output – the impact of Stage A3 can range from 0.13 to 0.26 $kgCO_2e/kg$. Thus, the A1-A3 impacts range from 0.47 to 0.6 $kgCO_2e/kg$.

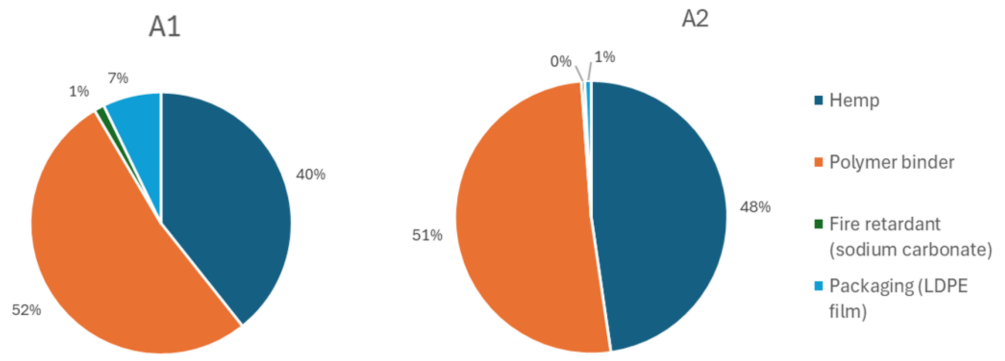
The biogenic carbon in the product for the declared unit (m^3) is 16.04 kg C – note that one kg biogenic carbon corresponds to 44/12 $kgCO_2$. There is no biogenic carbon in the packaging.

6.0 LCA Interpretation

The figures and charts below offer visualisation of the impact data.

A1 and A2

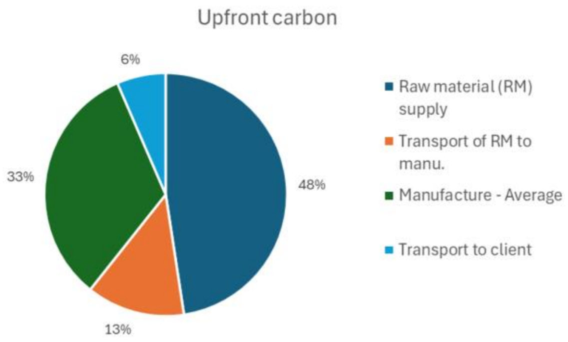
The pie charts below show the proportional split of the material inputs for the product system (including packaging) for Stage A1 and A2, ie raw material production and transport to manufacture. In both stages, the majority of the impacts come from the polymer binder. Despite only accounting for 9% by mass, the carbon intensity of its production in, and transport from, South Korea is very high. To reduce the impact of the IndiTherm® product, this is a key target area – replacing the polymer based binder with a bio-based binder, or increasing the recycled content of the polymer, would help drive down the A1 emissions. Additionally, a more local supply with minimal transport via road would improve A2 emissions as well as potentially A1 emissions, depending on the carbon intensity of the energy mix in the country of manufacture.

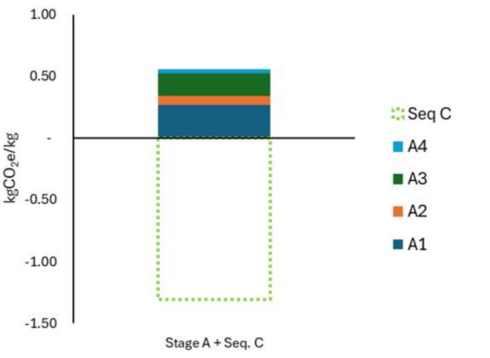


Upfront carbon

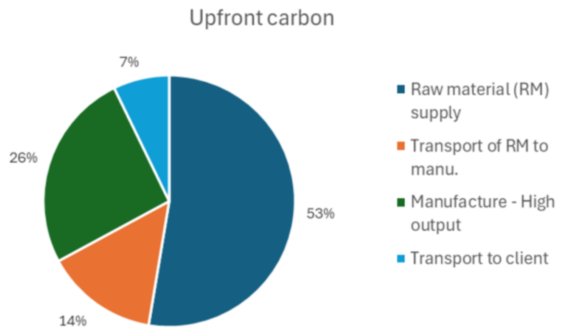
The three sections below show the A1-A4 results for the three Stage A3 scenarios - average, conservative, and high output. Note that the impacts of A5 are not included in the visualisation as they are negligible. In all cases, Stage A1 (raw material supply) accounts for the highest proportion of impacts, followed closely by the manufacture stage. Reducing emissions in A1 should be a priority (as described above) as well as reducing manufacturing emissions. As IndiNature scales up its operations and improves manufacturing efficiencies, generating a higher output (eg m^3 product per day) for minimal consumption increase, the A3 value will reduce to be more in line with the high output scenario (and better). This will drive down overall upfront carbon emissions, as shown in the bar charts on the left. Increasing the renewable energy contribution utilised at the manufacture facility would also significantly reduce A3 emissions and should be prioritised. For example, if all the electricity consumed was generated by wind turbines, the A3 impact could be as low as 0.4 $kgCO_2e$ per declared unit (m^3), which would result in an upfront impact of 17.34 $kgCO_2e$ per declared unit (m^3) – 0.39 $kgCO_2e/kg$.

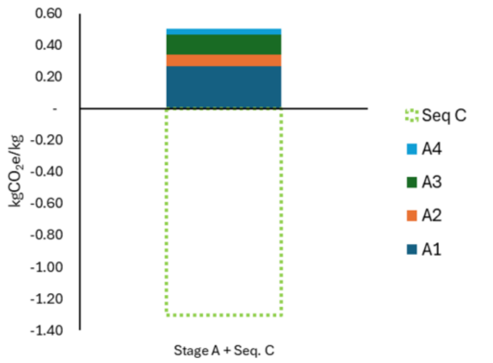
Average A3



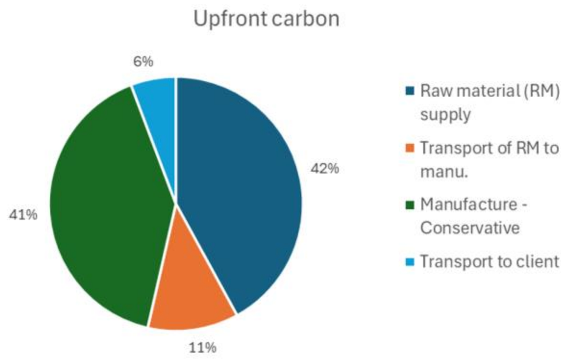


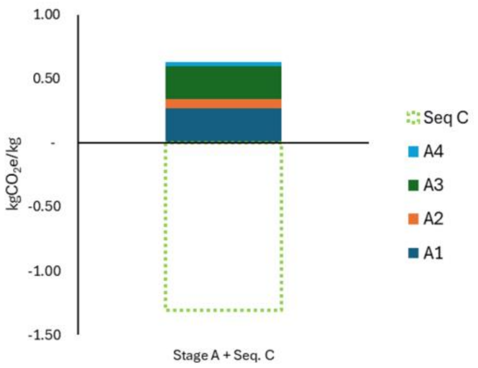
High output A3





Conservative A3





Throughout the useful life of the product, up to the point that it becomes waste, the biogenic carbon that is sequestered (stored) in the IndiTherm® insulation is 1.31 $kgCO_2/kg$. Therefore, when taking this into account, the overall carbon impact of IndiTherm® from cradle to gate (ie Stage A1-A3) is -0.79 $kgCO_2e/kg$, under the average A3 scenario.

Whole life (A-C)

The pie chart below shows the proportional split of impacts across the life cycle stages, for the average A3 scenario. Biogenic carbon is excluded here as, due to the LCA methodology, it balances out over the whole life cycle (absorbed in A1, emitted in C3). The EoL impacts are due to the transportation of the product removed from the building back to the manufacturing site (with an assumed distance of 300 km) for recycling. The total A-C impact of the IndiTherm® product is 26.8 $kgCO_2e/m^3$, or 0.6 $kgCO_2e/kg$, for the average A3 scenario. Depending on the A3 scenario, the impacts range from 24.4 to 30.14 $kgCO_2e/m^3$, or 0.54 to 0.67 $kgCO_2e/kg$.