Updated: December 2021

Shelter Methodology for the Assessment of Carbon

Step-by-Step User Guide

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What is SMAC?

SMAC has been developed by BRE Trust, the Environment Community of Practice, and WWF-US to support the comparison of shelter solutions in terms of their kg CO_2 equivalent emissions. It is intended as a decision-support tool to help identify the most carbon-efficient shelter option. It is not:

- A complete summary of environmental impacts a shelter option may or may not have.
- An accurate assessment of the kg CO_2eq impact for the specific materials used in all parts of the world.
- A tool designed for use in more complex building structures.

It is:

- A tool for quick comparison of generic options for temporary or transitional shelter options.
- A provider of a "good enough" comparative metric across sheltering options that can inform decision-making and environmental impact monitoring and reporting.

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What is SMAC?

SMAC allows for comparison of up to 4 different shelter types in terms of their embodied carbon equivalent emissions on the following criteria.

1. The component materials
2. Packaging
3. Transport
4. End of Life

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What do you need to know to use SMAC?

SMAC is intended to be simple-to-use, with no expert knowledge required. I order to complete the process and get a kg CO_2eq figure for your shelter options, you should know:

- A list of the shelter components and materials
- The amount of material used in kg
- The type of packaging used for the materials
- The transportation distances and methods from point of source of materials to use and disposal (there is further guidance in the tool on this if accurate distances are not known)

The information found in a bill of quantity should be enough to use the tool

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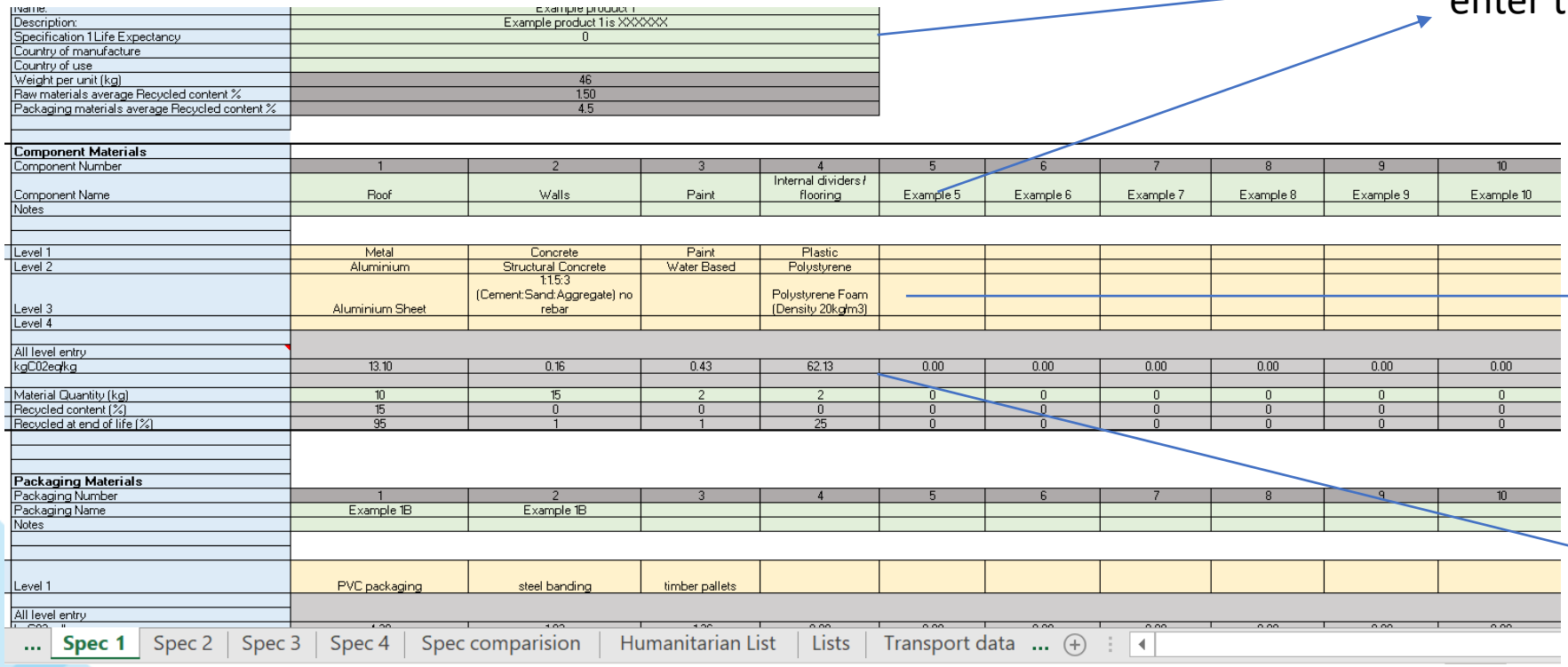
Using the SMAC Tool



Name:	Example product 1									
Description:	Example product 1 is XXXXXX									
Specification 1 Life Expectancy	0									
Country of manufacture										
Country of use										
Weight per unit (kg)	46									
Raw materials average Recycled content %	1.50									
Packaging materials average Recycled content %	4.5									
Component Materials										
Component Number	1	2	3	4	5	6	7	8	9	10
Component Name	Roof	Walls	Paint	Internal dividers / flooring	Example 5	Example 6	Example 7	Example 8	Example 9	Example 10
Notes										
Level 1	Metal	Concrete	Paint	Plastic						
Level 2	Aluminium	Structural Concrete	Water Based	Polystyrene						
Level 3	Aluminium Sheet	1:1.5:3 (Cement:Sand:Aggregate) no rebar		Polystyrene Foam (Density 20kg/m3)						
Level 4										
All level entry										
kgC02eq/kg	13.10	0.16	0.43	62.13	0.00	0.00	0.00	0.00	0.00	0.00
Material Quantity (kg)	10	15	2	2	0	0	0	0	0	0
Recycled content (%)	15	0	0	0	0	0	0	0	0	0
Recycled at end of life (%)	95	1	1	25	0	0	0	0	0	0
Packaging Materials										
Packaging Number	1	2	3	4	5	6	7	8	9	10
Packaging Name	Example 1B	Example 1B								
Notes										
Level 1	PVC packaging	steel banding	timber pallets							
All level entry										

... | Spec 1 | Spec 2 | Spec 3 | Spec 4 | Spec comparision | Humanitarian List | Lists | Transport data ...

Green boxes denote free text fill boxes, usually for descriptive information or to enter transportation distances

Yellow boxes are drop down lists – please note that upon opening a drop down list, you may have to scroll to the top of the list in order to see all available options

Grey boxes will show results

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Using the tool – Component Materials

B	C	D	E
Specification 1			
General product details			
Name:	Example product 1		
Description:	Example product 2		
Weight per unit	270		
Raw materials average Recycled content %	15%		
Packing recycled average content %	6%		
Raw materials			
	1	2	3
Component name	Example 1A	Example 1A	Example 1A
Notes			
Level 1	Rock	Wood and Boards	Composite
Level 2		Timber	ss Fibre Reinforced Pla
Level 3		Bamboo	Polyester Resin
Level 4			GFRP Composite Poles
kgC02eq/kg		0.852	9.9
Quanity (kg)	120	25	50

Brick
Composite
Concrete
Glass
Metal
Paint
Plastic
Rock

Insert the raw materials used in the shelter components, selecting from the drop down lists

After selecting the type of material, you will be asked for a more specific sub-set to identify the material used

Add the quantity of each material component (in kg)

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Using the Tool - Packaging

	Packaging Materials			
	Packaging Number	1	2	3
	Packaging Name (relevant component)	Example 1	Example 2	Example 3
	Notes			
(A)	Packaging 1			
	All level entry			
	kgC02eq/kg	0.00	0.00	0.00
(B)	Quantity (kg)	0	0	0
(C)	Recycled content (%)	0	0	0
(D)	Recycled at end of life (%)	0	0	0
(A)	Packaging 2			
	All level entry			
	kgC02eq/kg	0.00	0.00	0.00
(B)	Quantity (kg)	0	0	0
(C)	Recycled content (%)	0	0	0
(D)	Recycled at end of life (%)	0	0	0
(A)	Packaging 3			
	All level entry			
	kgC02eq/kg	0.00	0.00	0.00
(B)	Quantity (kg)	0	0	0
(C)	Recycled content (%)	0	0	0
(D)	Recycled at end of life (%)	0	0	0

	Summary – Components and Packaging			
(A)	Weight Per component (Kg) excluding packaging	0	0	0
(B)	Weight Per component (Kg) including packaging	0	0	0
(C)	Component recycled content (%)	0.00	0.00	0.00
(D)	Packaging recycled content (%)	0	0	0

Repeat the process for the packaging materials, selecting from the drop down list the materials used and adding the quantity in kg.

There are 3 different packaging options per component. The packaging for each particular component should be selected in the same column (N.B. you do not need to fill all 3 for the tool to work)

This will then give you an overall view of your shelter specifications

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Using the Tool – Transport (Multiple source locations)

Transportation of Packaged Component	1	2	3	4	5	6
Lorry (km)	150	0	0	0	150	0
Train (km)	0	200	150	450	500	150
Ship (km)	350	0	300	0	500	0
Air (km)	0	300	0	0	0	900
Impact (kg CO2 eq)	0.255518662	2.242769392	0.053571418	0.084981132	0.329588272	27.5223549

If all the components are sourced from different locations, then use this table to fill in the distances (km) travelled per mode for each shelter component.

Fill out the transportation table for each mode of transportation per component – this is a manual fill form so enter known distances in kilometres in the correct method of transport column.

If these distances are not known, you can refer to the “Transport Guide” tab in the spreadsheet for a rough distance calculator.

NOTE Please complete all green cells in transportation section to ensure the formula works – if the method of transport is not used, then a “0” should be entered.

Using the Tool – Transport (Single source location)

	Specification 1 - Transportation - Entire Unit	Only relevant when all the components of the shelter are sourced from the same location and transported together as a single unit.				
	Country of Manufacture	0				
		Lorry	Train	Ship	Air	
(M1)	Country of Origin to Point of Arrival in Country (km)	0	0	0	0	Please enter km travelled into all the releva
(M2)	Point of Arrival to Warehouse / Store (km)	0	0	0	0	Please enter km travelled into all the releva
(M3)	Warehouse to Construction Site (km)	0	0	0	0	Please enter km travelled into all the releva
(M4)	Construction Site to Disposal Site (km)	0	0	0	0	Please enter km travelled into all the releva
(M5)	Total distance travelled	0	0	0	0	
(N)	Weight of materials (kg)	61	61	61	61	

Use this section for transport if all the components for the entire shelter unit are sourced from a single source location and transported together as a unit.
Fill out the transportation table for each stage of transportation – this is a manual fill form so enter known distances in kilometres in the correct method of transport column.

If these distances are not known, you can refer to the “Transport Guide” tab in the spreadsheet for a rough distance calculator.

NOTE Please complete all green cells in transportation section to ensure the formula works – if the method of transport is not used, then a “0” should be entered.

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Using the SMAC tool – End of Life

	Specification 1 - End of Life					
		1	2	3	4	
		Metal	Concrete	Paint	Plastic	
(O)	Kg CO2eq EOL	0.01	1.00	1.00	0.33	
(P)	Reused:					
(Q)	Recycled:					
(R)	Incineration:					
(S)	Landfill:					

End of life data is calculated based on the entries made in component materials above, information on the data calculation can be found in the “End of Life Data” tab

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Using the Tool – Results

	Specification 1 - Impact	
	Impact	**Kg CO2eq**
(A1)	Component materials:	64.69
(A2)	Packaging:	64.73
(A3.1))	Transport (Per component - Multiple Source Locations)	30.49
(A3.2)	Transport (Whole Unit- Single Source Location)	0.00
(A4)	End of life:	6.04
	Total	**165.96**

	Impact	**Relative % CO2eq**
(B1)	Raw materials:	39.0%
(B2)	Packaging:	39.0%
(B3)	Transport:	18.4%
(B4)	End of life:	3.6%
	Total	**100%**

This is your total impact per shelter unit

You will then see a breakdown of the Kg CO_2 equivalent impact per shelter unit, per life cycle stage. Depending on what transport section you filled out, the other will appear as zero

This is the total Kg CO_2 equivalent of the unit

This shows the breakdown % of where the impact is coming from

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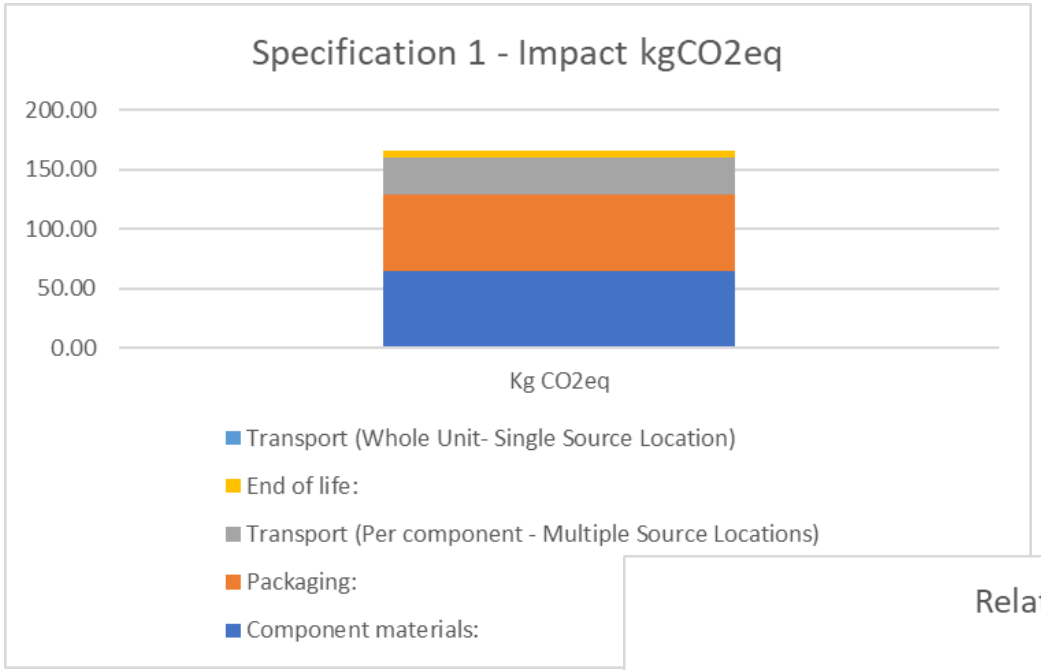
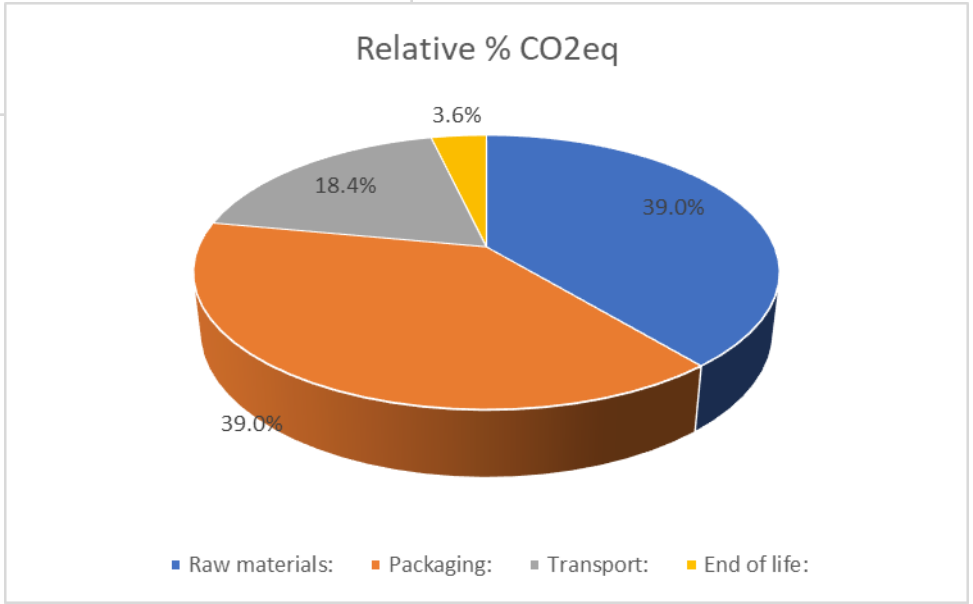
Using the Tool - Results

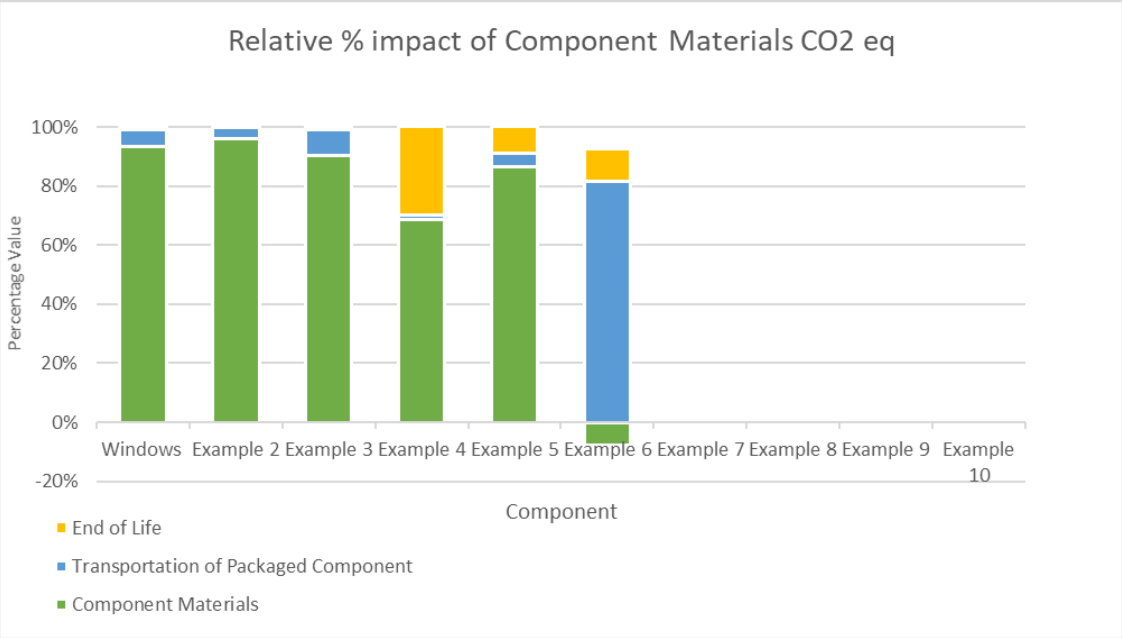




This is the output on each of the Spec sheets, showing the breakdown of CO_2 impact, which can help to inform decisions about how to reduce the impact of your shelter solution.

Here, we see that the component materials and the packaging makes up a larger proportion of the carbon impact. Therefore, a reduction in packaging or different materials could be considered.

Using the Tool - Results



You will also find a breakdown of the relative percentage impact of the different component materials, as entered into the first “Component Materials” section.

This breakdown allows you analyse the percentage impact of the individual materials, the impact coming from their transportation (including packaging) and their end of life impact.

A negative percentage impact represents the sequestered carbon that is included in the calculations for some materials.

Using the Tool - Comparison

You can compare up to four shelter specifications in SMAC by completing the 4 specification sheets and reviewing the “Spec Comparison” tab.

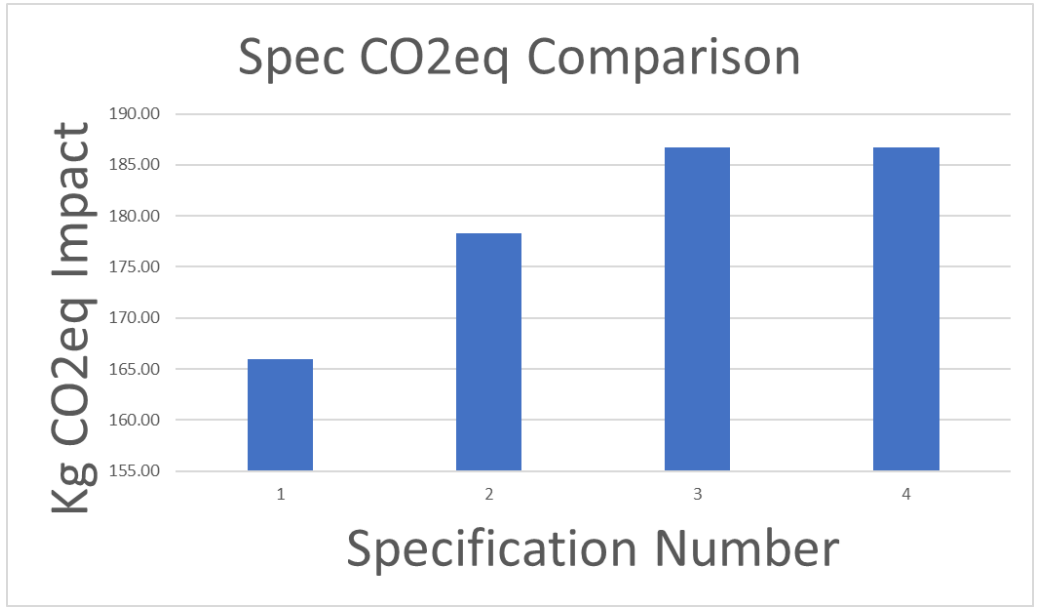
Specification 1	
General product details	
Name:	Example product 1
Description:	Example product 1 is XXXXXX
Specification 1 Life Expectancy	0
Country of manufacture	0
Country of use	0
Weight per unit (kg)	61
Raw materials average Recycled content %	1.50
Packaging materials average Recycled content %	19

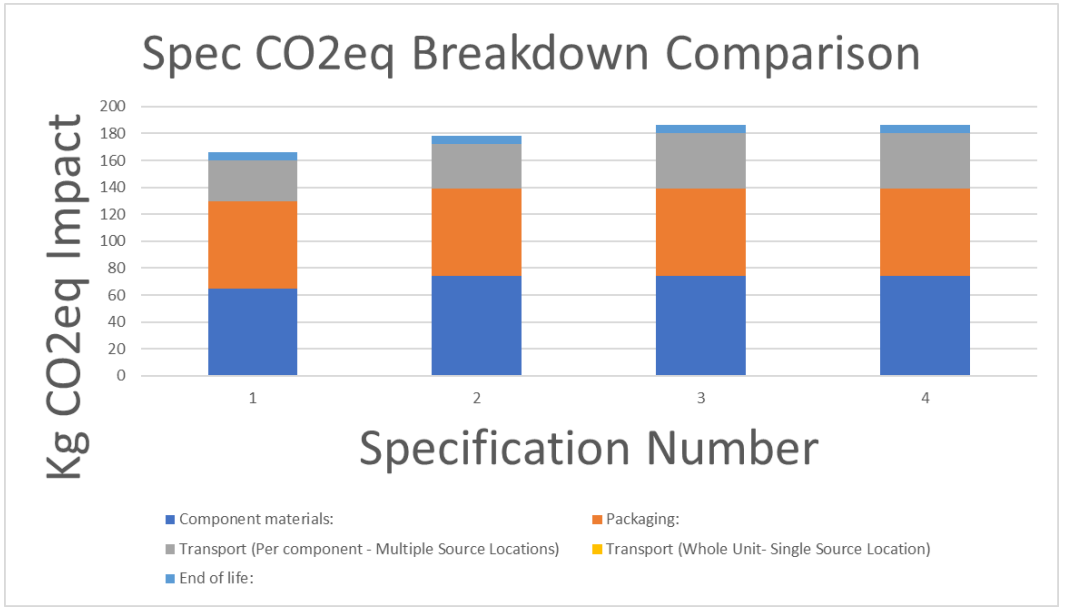
Specification 2	
General product details	
Name:	Example product 2
Description:	Example product 2 is XXXXXX
Specification 1 Life Expectancy	0
Country of manufacture	0
Country of use	0
Weight per unit (kg)	61
Raw materials average Recycled content %	1.5
Packaging materials average Recycled content %	19

Specification 1 - Impact	
Impact	**Kg CO2eq**
Component materials:	64.69
Packaging:	64.73
Transport (Per component - Multiple Source Lo	30.49
Transport (Whole Unit- Single Source Location)	0.00
End of life:	6.04
Total	165.96

Specification 2 - Impact	
Kg CO2eq	**Kg CO2eq**
Component materials:	74.39
Packaging:	64.73
Transport (Per component - Multiple Source Locatic	30.49
Transport (Whole Unit- Single Source Location)	0.00
End of life:	6.04
Total	175.66

Comparison Outputs





These are the graphic outputs provided by SMAC for the comparison of these 4 shelter types. On the left hand figure, you see a comparison of the overall kg CO_2 equivalent emissions per unit. On the right hand figure is the breakdown for each shelter specification into the different measurement criteria.

Shelter spec 1 is clearly having a lesser impact than 2, 3 and 4 in this example, and from reviewing the breakdown we can see that the majority of the increase is due to the transportation distances or methods used. One intervention to reduce the impact of the other shelters might therefore be to review transportation methods and find an alternative solution. Scale of the graphs is important to look at for context, as the bars themselves can be misleading in some cases.

Interpreting the Results

Why kg CO_2 equivalent emissions?

Measuring lifecycle environmental impact of shelter materials is a complex and time-consuming process. For shelter response, a quick comparison of different options is the most useful metric to help inform decision-making.

kg CO_2 equivalent emissions can be used as a proxy for environmental footprint, and allows for rapid comparison of some of the expected impacts from different shelter options.

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Interpreting the Results

The outputs from SMAC should not be taken as an accurate measure of the environmental impact of a specific shelter specification. The figures provided utilise publicly available data and provide a “good enough” calculation of the expected kg CO_2eq emissions for a given input.

This tool can help to inform decision-making and highlight potential areas where overall environmental impact might be reduced.

FAQs

What is a good / bad kg CO_2eq score?
The lower the score, the better the result. There is no limit either up or down. Some products, which have sequestrated carbon during their life, can have a negative embodied carbon result.

Does every part of the "information required" need to be completed for an accurate result?
In parts of the tool, it is possible to use default values, for example for the transport section. If details of a component are unknown or incomplete, please use the closest match. Information on material uses and potential proxies can be found in the reference list in the tool itself. The results are also not intended as an accurate representation of kg CO_2eq impact, but rather a guide based on available data, as highlighted in the reference list. Please note that the results obtained with SMAC are as good as the quality of the information entered.

Where has the source data come from?
The data from the tool has been taken from the Inventory of Carbon and Energy (ICE database), as well as from various environmental product declarations (EPD, such as those found in Eco Platform and Greenbooklive). The ICE database is a collation of aggregated and EPDs. Where data did not exist in ICE, and one EPD was available, that data point was used. Where several EPDs were available, an average was used. All data sources have been referenced within the tool. Data for packaging, end of life and recycled content have been sourced from BRE.

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FAQs

If a material I want to use is not in the list, what do I use to continue?
Use the closest match available. More information on potential uses and material matches can be found in the reference materials list tab within the tool itself.

How often will the list of materials be updated?
The materials list as it has been provided by BRE is current as of July 2021. Dates of expiry for EPDs are provided in the reference list. However, the list of materials could be expanded at any time with either more materials or with manufacturers specific data. If you wish to add to the list of materials, please contact Charles Kelly at havedisastercallkelly@gmail.com for access to the open access tool, in order to make changes to the materials list.

Life Expectancy Field – what value should you enter?
The number of years or months the unit is designed to last for.

Why is there no option to indicate if wood has been responsibly sourced e.g. FSC?
Responsible sourcing of materials is not quantifiable in a life cycle assessment, which does not typically include social or economic impacts.

FAQs

Why can't the percentage recycled content value be changed?
The relationship between recycled content and environmental impact is not an easy one. If the percentage recycled content of a material is higher to the one stated in the tool, it cannot be assumed that its environmental impact will be decreased. A full environmental impact assessment of that material would need to be recalculated. Hence, it cannot be changed.

The percentage recycled content and recycle EOL values are based on which manufacturing region?
Both the percentage recycled content and recycled at end of life values are typical of the UK and EU practices. If you are interested in adding more region-specific data to the tool, you can access the editable version by contacting Charles Kelly at havedisastercallkelly@gmail.com.

Why is the End of Life value for Paint a complicated one to accurately apply within the tool?
The end of life of paint is associated with the substrate to which its applied. It is difficult to disaggregate it. For example, you would require the EOL value for painted timber vs. unpainted timber. However, in the tool due to lack of data we have provided the EOL for paint, which is more likely to be relevant for the paint left in the pot. This is a gap that might be addressed in the future.

Find out more

Walkthrough video (Now out of date for some functions within the tool)

Utilising kg CO_2eq in decision-making – Chapter 9 of InterAction's Roadmap for Research

LCA in the Shelter Sector – More information on SMAC's development

Reach out to havedisastercallkelly@gmail.com or Stephen.Alexander@bregroup.com for queries

SMAC Disclaimer

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