LCA analysis of INDUSTRIAL WOOD PACKAGING

SUMMARY SHEET LCA WOOD PACKAGING

Prouduct name	Industrial Wood packaging and derivatives
ISO Standards	**ISO** 14040:2021 Environmental management. Life cycle assessment. Principles and frameworks **ISO** 14044:2014 Environmental management. Life cycle assessment. Requirements and guidelines
PCR reference	**PCR** Packaging 2019:13

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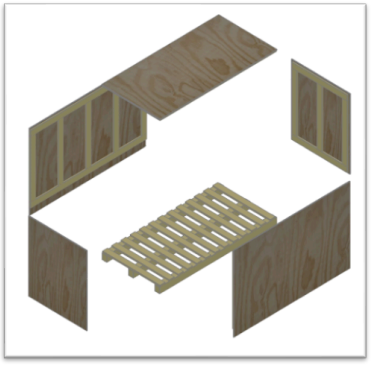
Product description



Wooden box for transporting machinery and/or industrial equipment of any kind and special products.
Components:

- **Bottom**, Spruce boards + spruce beams.
- **Header**, OSB Panels + spruce boards.
- **Sides**, OSB Panels + spruce boards.
- **Lid**, OSB Panels + spruce boards.

Slots are provided on both OSB panels and longitudinal beams to allow the passage of straps during transport.
Wood and wood derivatives certified for Sustainable Forest Management (SFM).

Productive process

1) Primary resources finding (OSB - Spruce beams- Spruce boards).
2) Cutting OSB panels to size with automatic panel sizing machine.
3) Milling Slots on OSB panels for sides with CNC pantograph
4) Cut to size spruce boards and spruce beams with automatic wood pack cutter.
5) Milling slots on spruce beams with CNC Pantograph.
6) Pneumatic manual packing assembly.

External dimensions of the package

- **Bottom**
  Spruce boards floor: 113 X 10 X 2,3 cm
  Longitudinal spruce beams: 240 X 11 X 9,5 cm
- **Header**
  OSB paneling: 119,4 X 137,6 X 0,9 cm
  Spruce crossbars: 113 X 10 X 2,3 cm
  Spruce uprights: 113 X 10 X 2,3 cm
- **Sides**
  OSB paneling: 237,6 X 149 X 0,9 cm
  Spruce crossbars: 238 X 10 X 2,3 cm
  Spruce uprights: 113 X 10 X 2,3 cm
- **Lid**
  OSB paneling: 240 X 120 X 0,9 cm
  Spruce stringers: 238 X 10 X 2,3 cm
  Spruce stringers: 96,5 X 10 X 2,3 cm

Weight

- Bottom: 41,9 Kg
- Header: 26,5 Kg
- Sides: 52,9 Kg
- Lid: 22,8 Kg

Total weight: 144,1Kg

Volumes

- External volume: **4,3** m^3
- Internal volume: **3,5** m^3

Materials

- Spruce: 85,04 kg (53,79 %)
- OSB: 59,01 kg (37,33 %)
- Steel: 14,04 kg (8,88 %)

System boundaries

The life cycle stages of industrial packaging included in the LCA analysis are those related to processes from cradle (including forestry) to grave: **A1- A2 - A3 - A4 - C3**, excluding use stages. The end-of-life phase considers wood prepared for recycling and associated lost emissions.

Functional unit/Declared

1 (a) wood industrial package and derivatives

Inventory Analysis (LCI)

Primary data collected directly at the company during the production process: Energy consumption measured with **HTGSC57** instrument. Secondary data taken from sector-specific databases during the modelling phase.

Final disposal (C3)

The final disposal of wood package is splitted as:

RECYCLING	Spruce **(93%)**
	OSB **(98%)**
	Steel **(90%)**
COMPOSTING	Wood **(3%)**
WASTE TO ENERGY	Wood **(4%)**

ACTIVITIES CARRIED OUT BY THE **DAGRI** AND **DIEF** DEPARTMENTS OF THE UNIVERSITY OF FLORENCE
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SUMMARY SHEET LCA WOOD PACKAGING: RESULTS AND SCENARIOS

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Impact Categories		Unit	Upstream	Core	Downstream	Total
Global Warming Potential (GWP)	Fossil	kg CO2 eq.	1,66E+01	3,25E+00	4,25E+00	2,41E+01
	Biogenic	kg CO2 eq.	-2,30E+02	3,42E+00	8,51E+00	-2,18E+02
	Land use and land transformation	kg CO2 eq.	7,22E-02	2,67E-02	2,75E-01	3,74E-01
	Total	kg CO2 eq.	-2,13E+02	6,69E+00	1,30E+01	-1,94E+02
Ozone Layer Depletion (ODP)		kg CFC 11 eq.	2,20E-07	8,70E-12	1,10E-08	2,31E-07
Acidification Potential (AP)		mol H+ eq.	9,92E-02	5,20E-03	3,60E+00	3,70E+00
Eutrophication Potential (EP)	Aquatic freshwater	kg P eq	9,26E-04	1,26E-05	-1,13E-03	-1,91E-04
	Aquatic marine	kg N eq	3,56E-02	1,61E-03	1,07E-01	1,44E-01
	Aquatic terrestrial	mol N eq.	3,89E-01	1,90E-02	1,66E+01	1,70E+01
Photochemical Oxidant Creation Potential (POCP)		kg NMVOC eq.	1,13E-01	3,93E-03	9,92E-01	1,11E+00
Abiotic Depletion Potential (ADP)	Metals and minerals	kg Sb eq	6,97E-06	2,58E-07	-8,24E-06	-1,01E-06
	Fossil resources	MJ, net calorific value	2,20E+02	4,39E+01	1,33E+02	3,97E+02
Water use		m^3 world eq. deprived	2,50E+00	1,92E+01	2,61E+01	4,78E+01

Impact for Categories

The table beside shows the cradle-to-grave life cycle impacts of industrial wood packaging and derivatives (SFM certified), excluding the use phase.

Most relevant Impacts

The most important impacts for this study are those concerning Global Warming Potential (GWP):

- GWP Fossil = **24,1 kg CO_2 eq.**
- GWP Biogenic = **-218 kg CO_2 eq.**
- GWP Land use and land transformation = **0,37 kg CO_2 eq.**
- GWP Total = **-194 kg CO_2 eq.**

Conclusions

Analysis of the environmental impacts of wood and wood-derivative packaging shows an excellent ecoprofile product, particularly related to the use of biogenic materials that offer an advantage due to their ability to absorb CO_2 during the formation phase, while offsetting emissions from fossil carbon. In addition, the foregone emissions from packaging recycling further contribute to achieving a negative GWP. These significant benefits result from the use of material from certified Sustainable Forest Management (SFM).

Scenario with recycling + Certified material SFM

Below, it is shown how the impacts would vary if the supply chain did not have a recycling system:

- GWP Fossil = **24,1 kg CO_2 eq.**
- GWP Biogenic = **10,17 kg CO_2 eq.**
- GWP Land use and land transformation = **0,37 kg CO_2 eq.**
- GWP Total = **+34,64 kg CO_2 eq.**

Scenario without recycling + NON-Certified material SFM

Below it is shown how the impacts would vary if the supply chain did not have a recycling system and the input material was not certified for Sustainable Forest Management (SFM):

- GWP Fossil = **24,1 kg CO_2 eq.**
- GWP Biogenic = **238,33 kg CO_2 eq.**
- GWP Land use and land transformation = **0,37 kg CO_2 eq.**
- GWP Total = **+262,81 kg CO_2 eq.**

The results of the study show that industrial wood packaging has a climate change impact (GWP total) of **-194kg CO_2 eq.** when recycling is cosnidering as end-of-life process and certified input material is used. Whitout recycling as an end-of-life process, the GWP total becomes positive, **+34.64kg of CO_2 eq.** If both recycling and certified input material are removed, the GWP total increases to **+262.81 kg CO_2 eq**.

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LCA analysis of WOODEN FOLDENING BOX

SUMMARY SHEET LCA WOODEN FOLDING BOX

Prouduct name	Wooden foldening box and derivatives
ISO Standards	**ISO** 14040:2021 Environmental management. Life cycle assessment. Principles and frameworks **ISO** 14044:2014 Environmental management. Life cycle assessment. Requirements and guidelines
PCR reference	**PCR** Packaging 2019:13

Product description

The plywood folding box is suitable for sea, air and land transport of any product. The sides are made of plywood providing a high degree of resistance to stresses due to loads during transport.
The corners, which are the points of greatest criticality, are made of galvanized steel. The profiles have slots that, when interlocked with the hooks applied to the sides, simplify assembly and fastening operations. It is customizable with logos, graphics, handles, hooks, dividers and more. The wood and derivatives used are certified for Sustainable Forest Management (SFM).

Components:

- **Bottom**, Spruce boards + Spruce beams
- **Header**, plywood panels + Spruce boards
- **Sides,** plywood panels + Spruce boards
- **Lid**, plywood panels + Spruce boards

Productive process

1) Primary resources finding (Spruce beams - Spruce boards - Steel).
2) Cut plywood panels to size with cutting machine.
3) Marking with ink stamping machines.
4) Cut to size spruce panels and spruce beamss with automatic wood pack cutter.
5) Create borders (Cover-frame) with Line create border.
6) Assembling lid and sides with Baykal pressing machine.
7) Assembling with CNC robot for nailing and automatic assembling machine.

System boundaries

The life cycle stages of industrial packaging included in the LCA analysis are those related to processes from cradle (including forestry) to grave: **A1- A2 - A3 - A4 - C3**, excluding use stages. The end-of-life phase considers wood prepared for recycling and associated lost emissions.

External dimensions of the package

- **Bottom**
120 x 80 cm
- **Sides**
119,2 x 79,2 x 75,0 cm
- **Lid**
120 x 80 cm

Volumes

- External volume: **0,69** m^3
- Internal volume: **0,87** m^3

Functional unit/Declared

1 (a) wooden foldening box and derivatives

Weight

- Bottom: 19,9 Kg
- Sides: 12,5 Kg
- Lid: 4,9 Kg

Total weight: 37,3 Kg

Inventory Analysis (LCI)

Primary data was collected directly at the company during the production process: Energy consumption measured with **HTGSC57** instrument. Secondary data taken from sector-specific database during the modelling phase.

Materials

- Spruce wood: 17,1 kg (29,45 %)
- Plywood: 36,2 kg (62,35 %)
- Wood chips: 2,4 kg (4,13%)
- Steel: 2,36 kg (4,06%)
- Ink: 0,003 kg (0,01 %)

Final disposal (C3)

The final disposal of the wood package is:

RECYCLING	Spruce **(93%)**
	Plywood **(98%)**
	Steel **(90%)**
COMPOSTING	Wood **(3%)**
WASTE TO ENERGY	Wood **(4%)**

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SUMMARY SHEET LCA WOODEN FOLDING BOX: RESULTS AND SCENARIOS

Impact for Categories

The two tables below present the cradle-to-grave life cycle impacts of a folding box made of wood and wood derivatives (SFM certified), excluding the use phase. The first figure refers to the **Italian** context, while the second table refers to the **European** context.

Impact Categories		Unit	Upstream	Core	Downstream	Total
Global Warming Potential (GWP)	Fossil	kg CO2 eq.	1,79E+01	1,16E+01	1,37E+00	3,09E+01
	Biogenic	kg CO2 eq.	-8,23E+01	2,52E-02	2,23E+00	-8,00E+01
	Land use and land transformation	kg CO2 eq.	3,08E-02	1,33E-01	5,74E-03	1,70E-01
	Total	kg CO2 eq.	-6,44E+01	1,18E+01	3,61E+00	-4,90E+01
Ozone Layer Depletion (ODP)		kg CFC 11 eq.	3,53E-07	9,55E-09	1,19E-09	3,64E-07
Acidification Potential (AP)		mol H+ eq.	1,14E-01	2,17E-02	1,09E-02	1,47E-01
Eutrophication Potential (EP)	Aquatic freshwater	kg P eq	9,94E-04	4,84E-05	3,17E-06	1,05E-03
	Aquatic marine	kg N eq	2,82E-02	6,67E-03	1,41E-03	3,63E-02
	Aquatic terrestrial	mol N eq.	3,10E-01	8,14E-02	4,25E-02	4,34E-01
Photochemical Oxidant Creation Potential (POCP)		kg NMVOC eq.	8,66E-02	1,59E-02	5,37E-03	1,08E-01
Abiotic Depletion Potential (ADP)	Metals and minerals	kg Sb eq	1,86E-05	4,70E-07	1,58E-08	1,91E-05
	Fossil resources	MJ, net calorific value	2,29E+02	1,51E+02	1,11E+01	3,91E+02
Water use		m^3 world eq. deprived	4,72E+00	6,95E-01	1,53E-01	5,57E+00

ITALIAN CONTEXT

Distance of transportation taken: **100 km**

Most relevant impacts:

The most important impacts for this study are those concerning Global Warming Potential (GWP):

- GWP Fossil = **30,9 kg CO_2 eq.**
- GWP Biogenic = **-80 kg CO_2 eq.**
- GWP Land use and land transformation = **0,17 kg CO_2 eq.**
- GWP Total = **-49 kg CO_2 eq.**

Impact Categories		Unit	Upstream	Core	Downstream	Total
Global Warming Potential (GWP)	Fossil	kg CO_2 eq.	1,79E+01	1,16E+01	2,67E+00	3,22E+01
	Biogenic	kg CO_2 eq	-8,23E+01	2,52E-02	2,24E+00	-8,00E+01
	Land use and land transformation	kg CO_2 eq	3,08E-02	1,33E-01	1,77E-02	1,82E-01
	Total	kg CO_2 eq	-6,44E+01	1,18E+01	4,93E+00	-4,77E+01
Ozone Layer Depletion (ODP)		kg CFC 11 eq.	3,53E-07	9,55E-09	1,19E-09	3,64E-07
Acidification Potential (AP)		mol H^+ eq.	1,14E-01	2,17E-02	1,29E-02	1,49E-01
Eutrophication Potential (EP)	Aquatic freshwater	kg P eq	9,94E-04	4,84E-05	7,89E-06	1,05E-03
	Aquatic marine	kg N eq	2,82E-02	6,67E-03	2,05E-03	3,69E-02
	Aquatic terrestrial	mol N eq.	3,10E-01	8,14E-02	5,01E-02	4,42E-01
Photochemical Oxidant Creation Potential (POCP)		kg NMVOC eq.	8,66E-02	1,59E-02	1,50E-01	2,53E-01
Abiotic Depletion Potential (ADP)	Metals and minerals	kg Sb eq	1,86E-05	4,70E-07	1,00E-07	1,92E-05
	Fossil resources	MJ, net calorific value	2,29E+02	1,51E+02	2,86E+01	4,09E+02
Water use		m^3 world eq. deprived	4,72E+00	6,95E-01	1,68E-01	5,58E+00

EUROPEAN CONTEXT

Distance of transportation taken: **400 km**

Most relevant impacts:

The most important impacts for the purpose of the study are those concerning Global Warming Potential (GWP):

- GWP Fossil = **32,2 kg CO_2 eq.**
- GWP Biogenic = **-80 kg CO_2 eq.**
- GWP Land use and land transformation = **0,18 kg CO_2 eq.**
- GWP Total = **-47,7 kg CO_2 eq.**

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Conclusions

Analysis of the environmental impacts of wood and wood-derivative packaging shows an excellent ecoprofile product, particularly related to the use of biogenic materials that offer an advantage due to their ability to absorb CO_2 during the formation phase, while offsetting emissions from fossil carbon. In addition, the foregone emissions from packaging recycling further contribute to achieving a negative GWP. These significant benefits result from the use of material from certified sustainable forest management.

Scenario without recycling + Certified material SFM (italian context)

Below, it is shown how the impacts would vary if the supply chain did not have a recycling system:

- GWP Fossil = **53,7 kg CO_2 eq.**
- GWP Biogenic = **-23,84 kg CO_2 eq.**
- GWP Land use and land transformation = **0,20 kg CO_2 eq.**
- GWP Total = **30,06 kg CO_2 eq.**

Scenario without recycling + NON-Certified material SFM (italian context)

Below it is shown how the impacts would vary if the supply chain did not have a recycling system and the input material was not certified for sustainable forest management:

- GWP Fossil = **53,7 kg CO_2 eq.**
- GWP Biogenic = **32,36 kg CO_2 eq.**
- GWP Land use and land transformation = **0,20 kg CO_2 eq.**
- GWP Total = **86,26 kg CO_2 eq.**

The results of the study show that wooden folding box has a climate change impact (GWP total) of **-47.7 kg CO_2 eq** when recycling is cosnidering as end-of-life process and certified input material is used. Whitout recycling as an end-of-life process, the GWP total becomes positive, **+30.06 kg of CO_2 eq.** If both recycling and certified input material are removed, the GWP total increases to **+86.26 kg of CO_2 eq.**

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