Interreg Sudoe

EUROPEAN UNION

IMIP_
Innovative Eco-Construction System Based on Interlocking Modular Insulation Wood & Cork-Based Panels

European Regional Development Fund

TASK 4.3 Life Cycle Analysis (harvest, transport, first and second transformation, use, disassembly and recycling) (SimaPro) D 4.3.1 Life Cycle Analysis of interlocking panels

IMIP-SOE3/P3/E0963
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PROJECT CONTEXT

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ACRONYMS

FU: Functional Unit

LCA: Life Cycle Assessment

E-LCA: Life Cycle Assessment (stand for environmental life cycle assessment)

LCI: Life Cycle Inventory (stand for environmental life cycle inventory)

LCIA: Life Cycle Impacts Assessment

LCC: Life Cycle Costing

s-LCA: Social Life Cycle Assessment

CLT: cross-laminated-timber

PEFC: Programme for the Endorsement of Forest Certification

OSB: Oriented Strand Board

1. INTRODUCTION

This Project is about taking actions to achieve the triple balance line; economic, ecological, and social both in the life cycle of materials and processes and in the useful life of the building systems that will be developed in this project based on wood and natural cork.

Task 4.3 in IMIP addresses Life Cycle Assessment (LCA) of the different products developed during the project. The aim is to endorse the future manufacturers in the development of the products from a sustainability point of view.

The aim is of this LCA is to allow comparative impacts scenarios between similar industrialized products. The LCA in Task 4.3 will build on the data and results from Task 1.5.1, technical report developed in WP1 and assessed and optimized throughout WP4.

This document presents the goal and scope for the LCA in Task 4.3. Defining goal and scope is the first and one of the very key steps when performing life cycle assessments and similar analyses. The idea is to clearly specify "what the analysis and modelling will cover, for whom it is intended, and how it is planned to be used." ISO 14040 lists the elements that are expected in a goal and scope specification of an LCA.

2. OBJECTIVES

The aim of the present technical report is to determine the environmental impact for four different CLT panels due to different indicators. These panels will be assessed using Simapro 9.4.0.3 LCA software.

2.1 Process description

LCA is a method to calculate the environmental impact of a product over its entire life-cycle. In this context, the term 'product' also includes services. Taking the entire product life-cycle into consideration – from resource extraction to production, use, and disposal – guarantees an integrated evaluation of all inputs and outputs, thus making sure negative environmental impacts aren't shifted to other life cycle phases of the product.

The methodology is defined in the ISO 14040/14044 standard. For the analysis of the environmental impact all materials, resources and the energy used should be

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included. Through an LCA is possible to increase the sustainability of the products assessed in different categories.

2.2 Goal and intended application

The LCA presented has been developed arises in the context of the validation of the sustainability of IMIP products and their technical documentation performed by parallel tasks in WP4. The objective of the performed LCA is to endorse manufacturers, and all agents interested in the implementation of the different IMIP products developed within the project by providening technical documentation and values in sustainable terms. The methodology applied according to ISO 14040/14044 standard sets a proper structure for future research such as LCC or S-LCA to complete a triple perspective assessment.

Furthermore, results of the study are intended to be disclosed to the public in future congresses or scientific publications about the topic.

2.3 Intended audience

The intended audience is formed by IMIP products manufacturers, and all agents interested in the implementation of the different IMIP products developed within the project. Also, the LCA results are foreseen for a broader target audience, such as industry and end-customers.

3. PRODUCT SPECIFICATION

3.1 Product system definition

Figure 1: Picture of IMIP type C production

The four CLT section panels under study present the following characteristics:

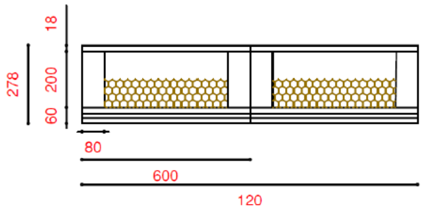

Figure 2: IMIP type A detail

Type A (roof): CLT of 60mm (3 layers of 20mm) + ribs of 80x200mm + Oriented Strand Board (OSB) of 18mm. Total thickness of 278mm. The OSB layer is considered as structural, whilst the cork layer is not considered structural. Studied as roof element with flexural loads.

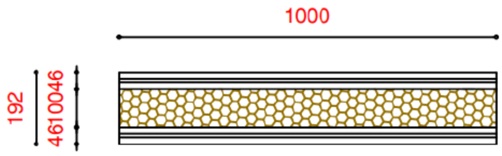

Figure 3: IMIP type B detail

Type B (sandwich roof): CLT of 46mm (2 layers of 14mm + oriented strand board layer of 18mm) + 100mm cork insulation + CLT of 46mm. Total thickness of 192mm.

The cork layer is not considered structural. Designed for small spans.

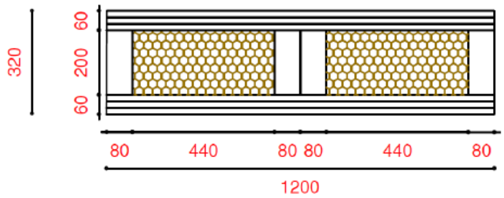

Figure 4: IMIP type C detail

Type C (slab): CLT of 60mm (3 layers of 20mm) + ribs of 80x200mm + CLT of 60mm. Total thickness of 320mm. The cork layer is not considered structural. Studied as slab element with flexural loads.

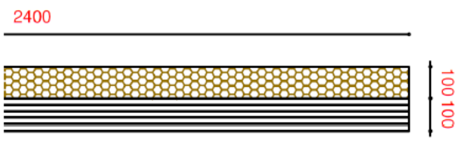

Figure 5: IMIP type D detail

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Type D (partition): CLT of 100mm (5 layers of 20 mm) + 100mm cork insulation. Total thickness of 200mm. The cork layer is not considered structural. Studied as wall element under compression load with wind load.

The possible configuration developed in WP4 in order to cross-matching the different features of the panel types are shown in the following Table 1:

Table 1: IMIP panels possible configurations.

Product		Board Type 1	Thickness Board 1 (mm)	Type inner	Thickness inner (mm)	Board Type 2	Thickness Bard 2 (mm)
Slab		CLT-OSB	46	Cork + rib	200	CLT-OSB	46
		CLT	60			CLT	60
		CLT	100			CLT	100
		CLT	120			CLT	120
		CLT	140			CLT	140
Roof		CLT-OSB	46	Cork + rib	200	OSB	18
		CLT	60				
	(sandwich)	CLT	100	Cork	100	CLT-OSB	46
		CLT	120				
		CLT	140				
Wall		CLT-OSB	46	Cork	60		
		CLT	60		80		
		CLT	100		100		
		CLT	120		120		
		CLT	140		140		
Partition	(sandwich)	CLT-OSB	46	Cork	100	CLT-OSB	46

3.2 Base materials / Ancillary materials

IMIP panels are produced from pine (PEFC certified), which has a wood moisture content of u=12% (+/-2%). For the gluing (area/finger joint) a bicomponent (A+B) polyurethane (PUR) adhesive according to EN 15425 is used. Wood-based panels for use in construction are used such as OSB-3 wooden composite boards in accordance with EN 13986, or in accordance with a European Technical Assessment. As insulating material, loose cork and cork panels are used according to UNE-EN 14304:2017 specifications.

3.3 Packaging

The products will be protected with various PE foil and on customer request, with edge protection systems such as carton to replace PE.

3.4 Reference service life

IMIP panels are compliant with CLT (cross-laminated timber) in its components and manufacture. CLT has been in use for over 100 years. Then used and maintained properly, no limit for its service life is stablish, so IMIP panels on a proper maintenance is expected to last equal that building service life. However, IMIP manufacturers fix the lifespan for LCA calculations in 50 years.

3.5 EOL scenarios

As developed WP2 E2.3, different potential EOL scenarios are possible. First and foremost, IMIP panels are designed for the possible disassembly and further recycling at the EOL, thus, this will be the scenario calculated for stage D in the LCA. If this not be possible, in other conditions they must be used as energy valorisation or biodegraded as composting material.

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4. LCA: Calculation rules

4.1 Declared unit

The definition of the functional unit (FU) of the study is crucial to compare different options for the individual kits and to compare the kits against a baseline situation (if applicable). The functional unit represents a quantification of the function and performance of the products under study.

The functional unit for IMIP panels is comparable to CLT panels already tested and standardized in the market. The most common functional unit will be one cubic metre (m^3) according to PCR 2012:01 - Construction products and construction services. Ver 2.2 Sub-PCR. Wood and wood-based products for use in construction.

It is important to define a FU also for components when meaningful for the technology providers and if different component alternatives need to be compared.

Table 2: IMIP panels functional unit details.

Name	Value	Unit
Declared unit	1	m^3
Type A_gross density	277,18	Kg/m^3
Type B_ gross density	431,14	Kg/m^3
Type C_area density	259,94	Kg/m^3
Type D_area density	353,25	Kg/m^3

4.2 System boundary

LCA type: from cradle to grave. This ecological life cycle assessment addresses the life cycle phases A1–A3, A4, A5, B1, B2, B3, B4, B5, B6, B7, C1, C2, C3, C4 and D in accordance with /EN 15804/. Since on the use of IMIP timber+cork panels no

pollution emissions or associated operative expenditures (energy) occur, B1 and B2 as also B6 and B7 are set to 0 (zero). B3 to B5 are declared as not relevant as MNR

4.3 Impact assessment methodology and selected impact categories

The E-LCA is performed using Simapro 9.4.0.3 LCA software. It has been used for modelling the lifecycle for the manufacture and disposal of the presented IMIP panels. To conduct the environmental LCA, the EN15804+A2 2020 impact assessment method is applied. All the relevant background data records for the

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manufacture and disposal were taken from the database ecoinvent 3.9.1 cut-off database. When primary data are not available, secondary data provided by Environmental Product Declarations (EPDs) and well-established databases are used.

The analysed impact categories for the different methods are reported below in Table 3. Material, waste, and energy indicators can be also considered.

Table 3: LCA selected indicators and corresponding categories.

Impact category	UNIT	Parameter
Climate change (total)	kg CO2 eq	GWP_t
Climate change (fossil)	kg CO2 eq	GWP_f
Climate change (biogenic)	kg CO2 eq	GWP_b
Climate change (land use and land use change)	kg CO2 eq	GWP_{luluc}
Climate change (CO2 uptake)	kg CO2 eq	GWP_{uptake}
Ozone layer depletion (ODP steady state)	kg CFC-11 eq	ODP
Acidification potential (accumulated exceedance)	kg SO2 eq	AP
Eutrophication	kg PO4 3- eq	EP
Human toxicity	kg 1,4-DB eq	HT
Photochemical oxidation	kg C2H4 eq	PO
Depletion of abiotic resources - elements, ultimate reserves	kg Sb eq	ADPE
Depletion of abiotic resources - fossil fuels	MJ	ADPF
Water use deprivation index - weighted water consumption	m^3	WDI

The assessment methods selected in order to calculate the above shown impact indicators: CML 2 baseline 2000 V2.05 / the Netherlands, 1997 (ODP, AP, EP, HT, PO); Berger et al 2014 (Water Scarcity) V1.01 (WDI); EPD (2018) V1.04 (ADPE, ADPF); IPCC 2021 GWP100 (incl. CO2 uptake) V1.01 (GWPt, GWPf, GWPb, GWPluluc, GWPuptake).

4.4 Estimates and assumptions

The same energy requirement is assumed for dismantling as that for assembly (worst-case scenario), since no specific data is available for this. The transport distances to the recycling plant are assumed to be on average 50 km. Transport distance between ancillary materials suppliers are assumed to be on average 400km, as well as installation average distance. modules.

The manufacturing begins with the considering of all the necessary raw materials for production including all preliminary chains and the CO2 sequestration of the raw materials (growth of wood in the forest). The CO2 storage is balanced and calculated

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according to the product nature in kg per kg of CO2 removed from the atmosphere is considered, where *pinus pinaster C16-18* capture 1,68 kg/kg, OSB 1,66 kg/kg and 5,67 for cork 5,67 kg/kg according to IVE environmental indicators database.

No further assessments or assumptions have been made.

4.5 Allocation procedures

Allocation is applied to partition the flows of a process when this produces two or more products as output. Allocation may be needed if by-products are generated during the manufacturing processes of the kits and components. In that case, economic or physical allocation will be applied.

4.6 Limitations

Limitations are linked to the assumptions of the present LCA. Results are referred to IMIP panels production and installation development finalized to validate the IMIP project with demo buildings located in Portugal, France and Spain. In the event of different application, data collection may need to be performed again together with the calculation and interpretation of results. However, the present study offers identification of hotspots and conclusions that can be considered as a starting point for assessing impacts in other retrofit interventions.

4.7 Data quality

Primary data are preferred for the foreground system. Furthermore, data quality is tracked for all information used and received from the manufacturers and product supplier of the ancillary materials.

4.8 Type and format of the report

The present report has been developed in accordance with ISO 14025 and EN 15804 +A2.

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5. LCA: Scenarios and additional data

The following technical information was provided by the product suppliers and can be used for the development of specific scenarios in the context of a building evaluation and future modifications of the present LCA.

5.1 Transport specifications (A2, A4)

For installation of the different IMIP products, average and mean assumptions have been done for all IMIP types.

Table 4: Transport specifications for A2, A4 stages

Transport for manufacturing (A2)		
Name	Value	Unit
Vehicle type	-	freight, lorry 16-32 metric ton, EURO4
Transport distance	400	km
Capacity utilisation	70	%
Average gross density products	330	Kg/m³
Transport to installation (A4)		
Name	Value	Unit
Vehicle type	-	freight, lorry 16-32 metric ton, EURO4
Transport distance	200	km
Capacity utilisation	70	%
Average gross density products	330	Kg/m³

5.2 Installation in a building (A5)

For installation of the different IMIP products, average and mean assumptions have been done for all IMIP types.

Table 5: Installation specifications for A5 stage

Name	Value	Unit
Auxiliary material brackets and screws	0,37	kg
Water consumption	0	m3
Other resources	0	kg
Electricity consumption power: drills, power screwdrivers	0,1	kWh

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Other energy carriers diesel for cranes and lifts	100	MJ

5.3 Operational energy and water requirements (B1-B7)

For operational stage of the different IMIP products, average and mean assumptions have been done for all IMIP types.

Table 6: Operational specifications for B1-B7 stages

Name	Value	Unit
Water consumption	0	m^3
Electricity consumption	0	kWh
Other energy carriers	0	MJ
Equipment output	0	KW

5.4 End of service life (C)

For the EoL stage, it has been considered that it will be necessary to carry out the assembly of the structure in reverse order to the assembly, since IMIP panels are not joined together using permanent joints, but rather perfectly removable joints. For EoL stage of the different IMIP products, average and mean assumptions have been done for all IMIP types.

Table 7: EoL specifications for C stage

Name	Value	Unit
Landfill	0	kg
Transport distance	200	km
Electricity consumption power: drills, power screwdrivers	0,1	kWh
Other energy carriers. diesel for cranes and lifts	100	MJ

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5.5 Benefits and loads beyond the system boundaries (D)

In stage D, considering that the IMIP panels will be recycled to make IMIP panels assuming an 80% of the original product, the environmental benefit of substituting new raw material has been considered.

Table 8: Benefits and load beyond sb specifications for D stage

Recycling scenario

Name	Value	Unit
Collected separately waste (screws)	2,58	kg
Collected separately waste (mix)	0	Kg
Reuse	0	Kg
Recycling material (screws)	2,58	kg
Recycling material (wood)	264	kg

6. LCA: RESULTS

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LCA; MND = MODULE NOT DECLARED)																
PRODUCT STAGE			CONSTRUCTION PROCESS STAGE		USE STAGE							EOL				BENEFITS BEYOND THE SYSTEM BOUNDARIES
Raw Material supply	Transport	Manufacturing	Transport from gate to the site	Assembly	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

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RESULTS OF THE LCA – ENVIRONMENTAL IMPACT 1M^3 IMIP TYPE A

Paramet.	Unit	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
GWP_{t}	kg CO2 eq	-190.70	10.83	9.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.05	10.84	0.00	0.00	-14.05
GWP_{f}	kg CO2 eq	38.30	10.80	9.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.04	10.80	0.00	0.00	-13.40
GWP_{b}	kg CO2 eq	0.95	0.09	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.09	0.00	0.00	-0.62
GWP_{luluc}	kg CO2 eq	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.03
GWP_{uptake}	kg CO2 eq	-230.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.05	0.00	0.00	0.00
ODP	kgCFC-11 eq	6.12E-6	1.98E-6	1.59E-6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.56E-6	1.98E-6	0.00	0.00	-1.74E-6
AP	kg SO2 eq	0.16	0.04	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.04	0.00	0.00	-0.06
EP	kg PO4 3-eq	0.04	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	-0.02
HT	kg 1,4-DB eq	19.40	4.11	1.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.05	4.11	0.00	0.00	-8.96
PO	kg C2H4 eq	0.01	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
ADPE	kg Sb eq	2.32E-4	3.61E-5	7.77E-5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.17E-6	3.61E-5	0.00	0.00	0.00
ADPF	MJ	610.00	162.00	131.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	124.00	162.00	0.00	0.00	-229.00
WDI	m3	0.25	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.42E-3	0.03	0.00	0.00	-0.15

RESULTS OF THE LCA – ENVIRONMENTAL IMPACT 1M^3 IMIP TYPE B

Paramet.	Unit	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
GWP_{t}	kg CO2 eq	-459.37	14.14	10.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.05	14.14	0.00	0.00	-113.58
GWP_{f}	kg CO2 eq	128.00	14.10	10.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.04	14.1	0.00	0.00	-79.7
GWP_{b}	kg CO2 eq	42.40	0.11	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.11	0.00	0.00	-33.7
GWP_{luluc}	kg CO2 eq	0.23	5.5E-3	2.0E-3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.00E-4	5.50E-3	0.00	0.00	-0.18
GWP_{uptake}	kg CO2 eq	-630.00	-0.07	-0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.07	0.00	0.00	0.00
ODP	kgCFC-11 eq	1.75E-5	2.57E-6	1.61E-6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.55E-6	2.57E-6	0.00	0.00	-9.89E-6
AP	kg SO2 eq	0.57	0.05	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.05	0.00	0.00	-0.37
EP	kg PO4 3-eq	0.22	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	-0.16
HT	kg 1,4-DB eq	119.00	7.15	8.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.13	7.15	0.00	0.00	-84.00
PO	kg C2H4 eq	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	-0.26
ADPE	kg Sb eq	0.00	4.71E-5	1.04E-5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.17E-6	4.71E-5	0.00	0.00	-7.50E-4
ADPF	MJ	2.06E3	211.00	136.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.66	0.00	0.00	-66.40
WDI	m3	1.26	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.4E-3	0.04	0.00	0.00	-0.94

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RESULTS OF THE LCA – ENVIRONMENTAL IMPACT 1M^3 IMIP TYPE C

Paramet.	Unit	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
GWP_t	kg CO2 eq	-354.60	8.54	9.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.05	8.50	0.00	0.00	-20.44
GWP_f	kg CO2 eq	41.20	8.51	9.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.04	8.47	0.00	0.00	-19.6
GWP_b	kg CO2 eq	1.12	0.07	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.07	0.00	0.00	-0.78
GWP_{luluc}	kg CO2 eq	0.08	3.33E-3	3.21E-3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.56E-4	3.32E-3	0.00	0.00	-0.06
GWP_{uptake}	kg CO2 eq	-397.00	-0.04	-0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.04	0.00	0.00	0.00
ODP	kgCFC-11 eq	7.39E-6	1.55E-6	1.58E-6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.55E-6	1.55E-6	0.00	0.00	-3.46E-6
AP	kg SO2 eq	0.17	0.03	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.03	0.00	0.00	-0.09
EP	kg PO4 3- eq	0.05	7.49E-3	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	7.46E-3	0.00	0.00	-0.03
HT	kg 1,4-DB eq	32.10	4.32	7.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.13	4.31	0.00	0.00	18.80
PO	kg C2H4 eq	0.01	1.07E-3	1.69E-3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.44E-3	1.07E-3	0.00	0.00	-0.01
ADPE	kg Sb eq	2.88E-4	2.85E-5	17.25E-6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.17E-6	2.85E-5	0.00	0.00	-1.86E-4
ADPF	MJ	670.00	128.00	130.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	124.00	127.00	0.00	0.00	-335.00
WDI	m3	0.32	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.42E-3	0.02	0.00	0.00	-0.21

RESULTS OF THE LCA – ENVIRONMENTAL IMPACT 1M^3 IMIP TYPE D

Paramet.	Unit	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
GWP_t	kg CO2 eq	-453.39	11.63	9.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.05	11.63	0.00	0.00	-103.17
GWP_f	kg CO2 eq	111.00	11.60	9.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.04	11.60	0.00	0.00	-70.80
GWP_b	kg CO2 eq	40.40	0.09	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.09	0.00	0.00	-32.20
GWP_{luluc}	kg CO2 eq	0.21	4.52E-3	1.39E-3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.56E-4	4.52E-3	0.00	0.00	-0.17
GWP_{uptake}	kg CO2 eq	-605.00	-0.06	-0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.06	0.00	0.00	0.00
ODP	kgCFC-11 eq	1.48E-5	2.11E-6	1.58E-6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.55E-6	2.11E-6	0.00	0.00	-8.48E-6
AP	kg SO2 eq	0.50	0.04	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.04	0.00	0.00	-3.34E-1
EP	kg PO4 3- eq	0.20	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	-0.14
HT	kg 1,4-DB eq	106.00	5.87	7.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.13	5.87	0.00	0.00	-75.20
PO	kg C2H4 eq	0.05	1.45E-3	1.65E-3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.44E-3	1.45E-3	0.00	0.00	-0.04
ADPE	kg Sb eq	9.10E-4	3.86E-5	6.67E-6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.17E-6	3.86E-5	0.00	0.00	-6.67E-4
ADPF	MJ	1.79E3	173.00	129.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	124.00	173.00	0.00	0.00	-1.16E3
WDI	m3	1.12	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	-0.83

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7. REFERENCES

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PARTNERS

ASSOCIATED PARTNERS

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