Life Cycle Assessment (LCA) study of C30 Concrete

ON BEHALF OF ÇIMKO ÇIMENTO VE BETON SAN. TIC. A.Ş.

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METSIMS SUSTAINABILITY CONSULTING | 11-07-2023

SUMMARY

This study aims to evaluate the environmental impacts of C30 concrete manufactured by Çimko Çimento ve Beton San. Tic. A.Ş. at company's three production plants located in Osmaniye, Kahramanmaraş and Altınşehir provinces in Turkey. This report focuses on the method of the Life Cycle Assessment (LCA) that calculates the potential impacts within the defined system boundary.

This LCA model was developed from the average data collected for the year 2022 from the manufacturer and the LCA models were developed for ***average C30 concrete***.

LCA was performed in agreement with the requirements of the Product Category Rules document for Construction Products and Construction Services regarding EN 15804+A2. Environmental impacts are calculated based on the required indicators.

The results of the LCA study performed for the above-mentioned product and showed that the raw material stage is the dominant life cycle stage in almost all environmental impact categories for the cement products.

This LCA is performed to gain an understanding of the environmental performance of the investigated products and its communications through LCA report. It is intended for engineers, specifiers, and green building consultants who are interested in sustainable infrastructure projects and their environmental evaluations.

The LCA part of this work is conducted by sustainability and LCA consultant Yıldıray Yılmaz and PhD. Hüdai Kara from Metsims Sustainability Consulting.

GENERAL ASPECTS

1.1 General information about the applicant company

SANKO, which has entered into the sector with the privatization of Adıyaman Cement Plant in 1995, continued its growth in the cement sector by commissioning the Narlı Plant at the end of 2007. Çimko, a subsidiary of Sanko Holding, has a voice in the sector and the region with its concrete plants located in Adıyaman, Narlı Cement Plants, Gaziantep Packaging Plant, Kilis Packaging Plant and Gaziantep, Kilis, Adıyaman, Şanlıurfa, Kahramanmaraş, Malatya, Osmaniye, Hatay, Adana, Kayseri and Mersin.

Çimko with the responsibility to its customers, employees, environment and society in all its processes, focuses on quality, stakeholder satisfaction and sustainability. Çimko works beyond today to meet the needs of tomorrow.

1.2 Commissioner of the LCA study, an internal or external practitioner of the LCA study

This LCA study is commissioned by Çimko Çimento ve Beton San. Tic. A.Ş. This LCA report is prepared by Metsims Sustainability Consulting. Metsims is a specialized consultancy based in the UK and Turkey, focusing on life cycle assessment, product sustainability, carbon management, and clean production.

The LCA work is carried out by LCA consultant Yıldıray Yılmaz from Metsims.

1.3 Date of the report, contact, and deliverable tools

The present report was issued in July 2023. Participants' contact details are provided in the following table.

Table 1. Contact information for the participants implied in the Çimko LCA project

Company	Address	Participant	Contact
Çimko Çimento ve Beton San. Tic. A.Ş.	Araban yolu üzeri 3.km Otogar Karşısı Şehitkamil / Gaziantep	Aslı Kokigil	+90 531 778 46 02
Metsims Sustainability Consulting	Sanayi Mah Hümeyra Sokak No:7/46-47 NEF09, B-Blok, 34415 Kâğıthane/İstanbul	Hudai Kara, PhD Managing Director	(+90) 212 281 13 33
Metsims Sustainability Consulting	Sanayi Mah Hümeyra Sokak No:7/46-47 NEF09, B-Blok, 34415 Kâğıthane/İstanbul	Yıldıray Yılmaz, MSc Sustainability Consultant	(+90) 212 281 13 33

1.4 Statement that the study has been conducted according to the requirements of this standard

This study is conducted according to the guidelines of ISO 14040 and ISO 14044 and the requirements given in the Product Category Rules (PCR) document for Construction (EN 15804:2012+A2:2019), UN CPC code of 375.

The inventory for the LCA study is based on the average data of production figures the investigated product produced by the manufacturer in their aforementioned plants for the year 2022. This LCA was modeled with SimaPro 9.5 LCA package using the Ecoinvent 3.9.1 database for secondary data.

GOAL and SCOPE OF THE STUDY

This LCA study evaluates the environmental impacts of followings:

- 1 m^3 of C30 concrete produced at company's three plants.

with cradle to grave (A + B + C +D) to understand the environmental impact related with the production of the investigated product. This application complies with EN 15804 harmonized standards.

The result of this LCA study will provide a better understanding of the environmental impacts that are originated by the manufacturing of ready-mix concrete. Therefore, the company may start to work for reducing its carbon footprint and the other environmental impacts.

1.5 Product Descriptions and Characterisation

This product is manufactured with CEM I & II cements in addition with fly ash and additives. CEM I cement used in the product has 91.42% clinker and CEM II cement has 90.39% clinker. The product is used mainly for the structural elements such as buildings and infrastructure works.

The product composition for the investigated three plants are displayed below tables.

Table 2: Raw material composition of the product for Osmaniye plant

Materials (for 1 m^3 C30 concrete)	Birim	Miktar
CEM II A-P 52,5 N(%90,39 KLİNKER)	kg	278.0
Kum Kırma	kg	1,923.0
Uçucu Kül	kg	30.0
HİPER Akışkanlaştırıcı Kimyasal Katkı	kg	3.69
SÜPER Akışkanlaştırıcı Kimyasal Katkı	kg	1.2
Water	kg	78

Table 3: Raw material composition of the product for Kahramanmaraş plant

Materials (for 1 m^3 C30 concrete)	Birim	Miktar
CEM II A-P 52,5 N(%90,39 KLİNKER)	kg	287.0
Kum Kırma	kg	2,029.0
Uçucu Kül	kg	20.0
HİPER Akışkanlaştırıcı Kimyasal Katkı	kg	3.7
SÜPER Akışkanlaştırıcı Kimyasal Katkı	kg	1.2
Water	kg	71

Table 4: Raw material composition of the product for Altınşehir plant

Materials (for 1 m^3 C30 concrete)	Birim	Miktar
CEM II A-P 52,5 N(%90,39 KLİNKER)	kg	280.0
Kum Kırma	kg	1,959.0
Uçucu Kül	kg	45.0
HİPER Akışkanlaştırıcı Kimyasal Katkı	kg	3.25
SÜPER Akışkanlaştırıcı Kimyasal Katkı	kg	0.98
Water	kg	73

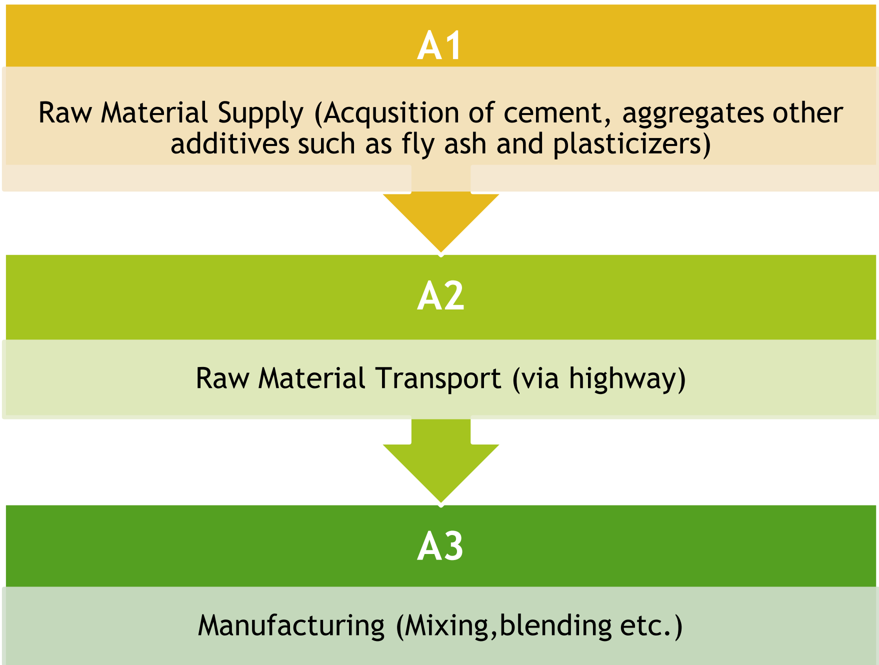

Figure 1: Flow diagram for cement production

1.6 Functional Unit / Declared Units

Declared unit for the study has been defined as $1m^3$ of average C30 concrete.

1.7 Declaration of construction product classes

Articles of cement is categorised in the European Construction products definition, and this declaration refers to that as per PCR for Construction Products and under UN CPC code 375. The data representative for concrete production stated in this report and are relevant for the year 2022.

1.8 System boundary

System boundary of the study has been defined as below:

The system boundary covers the below mentioned stages:

- Raw materials acquisition
- Raw materials transport,
- Production operations,
- Energy and water consumption, waste management,
- Transport of end product.
- Carbon uptake during the use phase
- End-of-life stages
- Benefits

The system boundary of the study is given below for each product considered.

1.8.1 System Boundaries for C30 Concrete

A1: Raw Material Supply

Raw material supply stage includes raw material extractionand pre-treatment processes before the production. Raw materials used in the product are cement, agrega, fly ash, and additives. Their impact are localized and modelled.

A2 : Raw Material Transport

Transport is relevant for delivery of raw materials and packaging materials to the plant/s. The transport distances and routes are calculated based on the given information from the manufacturer for 2022.

A3 : Manufacturing

This stage includes the manufacturing steps of concrete production at the considered plants. Electricity is used mainly during the production.

A4 : Transport to Customers

Transport of final product to customers are considered and the routes and distances are calculated accordingly. Transport routes were provided by the manufacturer for 2022.

B1: Use phase

During the use phase of the concrete, some of the CO_2 emitted during the manufacturing process are taken back. This is also called carbonation. Carbonation can take place during the lifetime of the concrete product. This uptake of CO_2 in the concrete thus reduces the net emission of CO_2 from the raw material part. To calculate calcination related impact during the use phase of concrete TS EN 16757 is followed. The title of this standard is called in Turkish as “Yapıların sürdürülebilirliği - Çevresel mamul beyanları - Beton ve beton elemanlar için mamul kategori kuralları”. This standard clearly defined parameters on how to calculate calcination related impacts. Following the standard, CO_2 uptake is calculated.

C1: Demolition

For the demolition of concrete, an average size excavator with 129 kW max. power is considered.

C2: Waste Transport

50 km distance is assumed for the discarded product to be carried to the waste processing area.

C3: Waste Processing

Calcination also occurs during crashing of the concrete to its finer particles. TS EN 16757 also provide methodological framework to calculate crashing related calcination impacts. This impact along with the electricity needed for a crusher are included.

C4: Disposal

It is assumed that 60%of the concrete is recycled as aggragete content and the rest is landfilled. This is modelled accordingly.

D: Benefits

The recycled concrete is assumed to substitute to use of crushed gravel need for further processes.

1.9 CO_2 certificates

Çimko Çimento ve Beton San. Tic. A.Ş. does not currently have CO_2 certification.

Life Cycle Inventory Analysis

1.10 Collecting data

Throughout this project, ISO 14040 and ISO 14044 guidelines are followed. The data used in this study were primary and secondary. Primary data are those collected directly from manufacturer/producer relevant to the life cycle stages modelled. If there is no primary data available, then data from the latest Ecoinvent database (Version: 3.9.1) available for SimaPro are used as secondary data.

Apart from environmental impacts from upstream supply chain of raw materials production, all production data collected from company's production lines. Raw materials production data were taken from the Ecoinvent database.

Transport data were taken from Ecoinvent but the tonnages hauled were all provided by the company (both for module A2 and A4). The source and amount of every raw material used in production were identified, and locations for transport with their means are obtained from the company. When more than one source and/or transport method was utilised, allocations were based on weighted averages.

1.11 Calculation Methods

After collecting all relevant data for each of the life cycle stages, the modelling was conducted using SimaPro life cycle assessment software. Methods used for the calculations are listed in the following table. These impact categories and their associated methods are retrieved from EN 15804 A2 document. Methods are present in SimaPro within EF Method (adapted) v3.1.

Table 5: Indicators used for the EPD

Impact Category	Indicator	Unit	Model
Climate change - total	Global Warming Potential total (GWP-total)	kg CO2 eq.	Baseline model of 100 years of the IPCC based on IPCC 2013
Climate change - fossil	Global Warming Potential total (GWP-fossil)	kg CO2 eq.	Baseline model of 100 years of the IPCC based on IPCC 2013
Climate change - biogenic	Global Warming Potential total (GWP-biogenic)	kg CO2 eq.	Baseline model of 100 years of the IPCC based on IPCC 2013
Climate change - land use and land use change	Global Warming Potential total (GWP-luluc)	kg CO2 eq.	Baseline model of 100 years of the IPCC based on IPCC 2013
Ozone Depletion	Depletion potential of the stratospheric ozone layer (ODP)	kg CFC 11 eq.	Steady-state ODPs, WMO 2014

Acidification	Acidification potential, Accumulated Exceedance (AP)	mol H+ eq.	Accumulated Exceedance, Seppälä et al. 2006, Posch et al., 2008
Eutrophication aquatic freshwater	Eutrophication potential, fraction of nutrients reaching freshwater end compartment (EP-freshwater)	kg P eq.	EUTREND model, Struijs et al., 2009b, as implemented in ReCiPe
Eutrophication aquatic marine	Eutrophication potential, fraction of nutrients reaching freshwater end compartment (EP-marine)	kg N eq.	EUTREND model, Struijs et al., 2009b, as implemented in ReCiPe
Eutrophication terrestrial	Eutrophication potential, Accumulated Exceedance (EP-terrestrial)	mol N eq.	Accumulated Exceedance, Seppälä et al. 2006, Posch et al.
Photochemical ozone formation	Formation potential of tropospheric ozone (POCP);	kg NMVOC eq.	LOTOS-EUROS ,Van Zelm et al., 2008, as applied in ReCiPe
Depletion of abiotic resources - minerals and metals	Abiotic depletion potential (ADPminerals& metals) for non-fossil resources	kg Sb eq.	CML 2002, Guinée et al., 2002, and van Oers et al. 2002.
Depletion of abiotic resources - fossil fuels	Abiotic depletion potential (ADP-fossil) for fossil resources	MJ, net calorific value	CML 2002, Guinée et al., 2002, and van Oers et al. 2002.
Water use	Water (user) deprivation potential, deprivationweighted water consumption (WDP)	m3 world eq. deprived	Available WAter REmaining (AWARE) Boulay et al., 2016
Particulate matter emissions	Potential incidence of disease due to PM emissions (PM)	Disease incidence	SETAC-UNEP, Fantke et al. 2016
Ionising radiation, human health	Potential Human exposure efficiency relative to U235 (IR)	kBq U235 eq.	Human health effect model as developed by Dreicer et al. 1995 update by Frischknecht et al., 2000
Ecotoxicity (freshwater)	Potential Comparative Toxic Unit for ecosystems (ETP-fw)	CTUe	Usetox version 2
Human toxicity, cancer effects	Potential Comparative Toxic Unit for humans (HTP-c)	CTUh	Usetox version 2
Human toxicity, noncancer effects	Potential Comparative Toxic Unit for humans (HTP-nc)	CTUh	Usetox version 2

Land use related impacts / soil quality	Potential Soil quality index (SQP)	dimensionless	Soil quality index based on LANCA

1.12 Selecting data / background data

Primary data used in this study were taken the manufacturer based on average production figures for 2022.. Use of raw materials, electricity, water use and waste data were taken for the relevant products. Emissions to air were not measured but taken from Ecoinvent database for any relevant energy-consuming processes.

Secondary data used in this study are taken from the Ecoinvent database, mainly because primary data from the upstream supply chain were not available (e.g. production of raw materials). However, Ecoinvent has comprehensive data on raw materials, and the ones used here were less than 10 years old.

1.13 Allocations

There are no co-products in the production of investigated products. Hence, there was no need for co-product allocation.

Mass allocation is followed throughout the study based on the production volumes of the product in the considered three plants.

1.14 REACH Regulation

No substances included in the Candidate List of Substances of Very High Concern for authorization under the REACH regulations are present in this product either above the threshold for registration with the European Chemicals Agency or above 0.1% (wt/wt).

Life Cycle Inventory Analysis and Estimated Impacts

1.15 Indicators for the Life Cycle Inventory Analysis as per EN 15804

Table 6: Description of System Boundary

	Product Stage			Construction Process Stage		Use Stage							End of Life Stage				Benefits and Loads
	Raw Material Supply	Transport	Manufacturing	Transport	Construction Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational Energy Use	Operational Water Use	Deconstruction / demolition	Transport	Waste Processing	Disposal	Future reuse. recycling or energy recovery potentials
Module	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Modules Declared	X	X	X	X	X	X	ND	ND	ND	ND	ND	ND	X	X	X	X	X
Geography	TR	TR	TR	TR	TR	TR	-	-	-	-	-	-	TR	TR	TR	TR	TR
Specific Data Used	>90%	>90%	>90%	>90%	-	-	-	-	-	-	-	-	-	-	-	-	-
Variation - products	NR					-	-	-	-	-	-	-	-	-	-	-	-
Variation - Sites	<10%					-	-	-	-	-	-	-	-	-	-	-	-

X = Included in LCA, ND = Not Declared

The results of the LCA study with the indicators according to EPD requirement are given in the following tables for the system boundaries (A + B + C + D) The system boundaries in tabular form for all modules are shown in the table above.

All energy calculations were obtained using Cumulative Energy Demand (LHV) methodology, while freshwater use is calculated with the addition of the water flows within the inventory. As per PCR requirements, net freshwater does not include cooling, turbine, salt (sole) and salt (ocean) water.

Output flows are given in the following tables according to following waste categories: Hazardous waste disposed of (HWD), Non-hazardous waste disposed of (NHWD), Radioactive waste disposed of (RWD), Components for re-use (CRU), Materials for recycling (MFR), Materials for energy recovery (MER), Exported energy per energy carrier (EE).

1.16 LCA results for 1 m^3 of C30 concrete

Impact Category	Unit	A1-A3	A4	B1	C1	C2	C3	C4	D
GWP - Fossil	kg CO_2 eq	2.56E+02	7.33E+00	1.41E+01	6.95E+00	2.36E+01	2.55E-01	5.61E+00	-2.70E-01
GWP - Biogenic	kg CO_2 eq	3.96E+00	3.81E-03	0.00E+00	1.59E-03	7.96E-03	7.17E-02	3.21E-03	-4.82E-04
GWP - Luluc	kg CO_2 eq	1.28E-01	3.71E-03	0.00E+00	7.82E-04	1.22E-02	6.24E-02	3.39E-03	-2.28E-04
GWP - Total	kg CO_2 eq	2.60E+02	7.34E+00	1.41E+01	6.95E+00	2.36E+01	3.89E-01	5.62E+00	-2.71E-01
ODP	kg CFC-11 eq	1.65E-06	1.12E-07	0.00E+00	1.10E-07	3.53E-07	3.53E-08	1.62E-07	-3.26E-09
AP	mol H+ eq	6.76E-01	1.78E-02	0.00E+00	6.44E-02	8.35E-02	3.76E-02	4.23E-02	-1.72E-03
*EP - Freshwater	kg P eq	3.58E-02	5.88E-04	0.00E+00	2.13E-04	1.92E-03	6.03E-03	4.67E-04	-6.32E-05
EP - Marine	kg N eq	1.78E-01	4.22E-03	0.00E+00	2.98E-02	2.75E-02	6.30E-03	1.62E-02	-4.84E-04
EP - Terrestrial	mol N eq	2.00E+00	4.33E-02	0.00E+00	3.24E-01	2.91E-01	5.66E-02	1.74E-01	-5.49E-03
POCP	kg NMVOC	5.66E-01	2.31E-02	0.00E+00	9.61E-02	1.12E-01	1.65E-02	6.05E-02	-1.68E-03
ADPE	kg Sb eq	4.62E-04	2.31E-05	0.00E+00	2.42E-06	7.54E-05	5.64E-06	7.79E-06	-1.27E-06
ADPF	MJ	1.18E+03	1.01E+02	0.00E+00	9.10E+01	3.32E+02	5.49E+01	1.40E+02	-3.52E+00
WDP	m^3 depriv.	1.45E+02	4.23E-01	0.00E+00	1.96E-01	1.47E+00	2.93E+00	6.17E+00	-2.23E-01

PM	disease inc.	5.12E-06	4.69E-07	0.00E+00	1.80E-06	1.88E-06	1.71E-07	9.25E-07	-2.50E-08
*IR	kBq U-235 eq	6.68E+00	8.76E-02	0.00E+00	4.32E-02	2.83E-01	4.33E-02	8.85E-02	-1.75E-02
**HTTP - C	CTUh	5.16E-08	3.01E-09	0.00E+00	2.13E-09	1.07E-08	1.13E-09	2.39E-09	-2.19E-10
**HTTP - NC	CTUh	1.86E-06	6.91E-08	0.00E+00	1.48E-08	2.38E-07	4.58E-08	2.99E-08	-2.84E-09
**SQP	Pt	4.21E+02	5.23E+01	0.00E+00	6.13E+00	1.98E+02	5.41E+00	2.78E+02	-2.71E+00
Acronyms	GWP-total: Climate change, GWP-fossil: Climate change- fossil, GWP-biogenic: Climate change - biogenic, GWP-luluc: Climate change - land use and transformation, ODP: Ozone layer depletion, AP: Acidification terrestrial and freshwater, EP-freshwater: Eutrophication freshwater, EP-marine: Eutrophication marine, EP-terrestrial: Eutrophication terrestrial, POCP: Photochemical oxidation, ADPE: Abiotic depletion - elements, ADPF: Abiotic depletion - fossil resources, WDP: Water scarcity, PM: Respiratory inorganics - particulate matter, IR: Ionising radiation, ETP-FW: Ecotoxicity freshwater, HTP-c: Cancer human health effects, HTP-nc: Non-cancer human health effects, SQP: Land use related impacts, soil quality.								
Legend	A1: Raw Material Supply, A2: Transport, A3: Manufacturing, A4: Transport, A5: Installation, B1: Use phase, C1: Demolition, C2: Waste transport, C3: Waste processing, C4: Disposal, D: Benefits								
***Disclaimer 1**	This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon and from some construction materials is also not measured by this indicator.								
****Disclaimer 2**	The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator.								

Impact Category	**Unit**	**A1-A3**	**A4**	**B1**	**C1**	**C2**	**C3**	**C4**	**D**
PERE	MJ	8.47E+01	1.37E+00	0.00E+00	5.18E-01	4.22E+00	1.82E+01	1.18E+00	-1.95E-01
PERM	MJ	0	0	0	0	0	0	0	0
PERT	MJ	8.47E+01	1.37E+00	0.00E+00	5.18E-01	4.22E+00	1.82E+01	1.18E+00	-1.95E-01
PENRE	MJ	1.18E+03	1.01E+02	0.00E+00	9.10E+01	3.32E+02	5.49E+01	1.40E+02	-3.52E+00
PENRM	MJ	0	0	0	0	0	0	0	0
PENRT	MJ	1.18E+03	1.01E+02	0.00E+00	9.10E+01	3.32E+02	5.49E+01	1.40E+02	-3.52E+00
SM	kg	2.95E+01	0	0	0	0	0	0	0
RSF	MJ	0	0	0	0	0	0	0	0
NRSF	MJ	0	0	0	0	0	0	0	0
FW	m^3	4.21E+00	1.69E-02	0.00E+00	7.65E-03	5.65E-02	2.22E-02	1.48E-01	-1.77E-02

Acronyms: PERE: Use of renewable primary energy excluding resources used as raw materials, PERM: Use of renewable primary energy resources used as raw materials, PERT: Total use of renewable primary energy, PENRE: Use of non-renewable primary energy excluding resources used as raw materials, PENRM: Use of non-renewable primary energy resources used as raw materials, PENRT: Total use of non-renewable primary energy, SM: Secondary material, RSF: Renewable secondary fuels, NRSF: Non-renewable secondary fuels, FW: Net use of fresh water.

Impact Category	Unit	A1-A3	A4	B1	C1	C2	C3	C4	D
HWD	kg	1.15E-06	0	0	0	0	0	0	0
NHWD	kg	1.51E-05	0	0	0	0	0	0	0
RWD	kg	0	0	0	0	0	0	0	0
CRU	kg	0	0	0	0	0	0	0	0
MFR	kg	0	0	0	0	0	1.47E+03	0	0
MER	kg	0	0	0	0	0	0	0	0
EE (Electrical)	MJ	0	0	0	0	0	0	0	0
EE (Thermal)	MJ	0	0	0	0	0	0	0	0

Life Cycle Interpretation

1.17 Overall summary

The LCA flow for Global Warming Potential (GWP) – Fossil, of the investigated products which is created with SimaPro LCA package and are shown in figure below. Included processes and their relative contributions are presented as carbon flow diagram.

The hot spot from an environmental performance view of a typical concrete production is the use of cement in the product. Due to high CO_2 emissions of cement production, it is important to model the cement used in the product accordingly. The cement used in the product is CEM I & CEM II types of cements with certain percentages. According to Figure 2, around 98% of the CO_2 emissions come from the materials used in the product. When only raw materials are considered, around 90% of the CO_2 impact for A1&A2&A3 stages solely comes from the use of cement. Both CEM I and II cements are localized with considering Turkish electricity grid mix.

Impact of other materials are relatively low compared with the impact of concrete. Similarly, considering 1 m^3 of concrete production, impact of raw material transportation becomes very low. Relatedly, effects of manufacturing process also becomes low when compared with A1 stage. During the manufacturing of concrete only electricity is used with minimal quantitites (0.025 kWh for 1 m^3 concrete production).

End of life stages are modelled based on the logical scenarios and current practices. The product is considered to be deconstructed with the use of electrical equipment and carried to the waste processing area by trucks. Then, the waste concrete is crushed with the electrical equipment and 60% of the waste concrete is assumed to be recycled. Among this 60% recycled waste concrete amount, 1% of the product is assumed to be substituting for gravel content for the further processes.

The relative impacts of all life cycle stages for manufactured concrete are shown in Fig 2. and Fig. 3.

Long-term emissions (> 100 years) are not taken into consideration in the impact estimate.

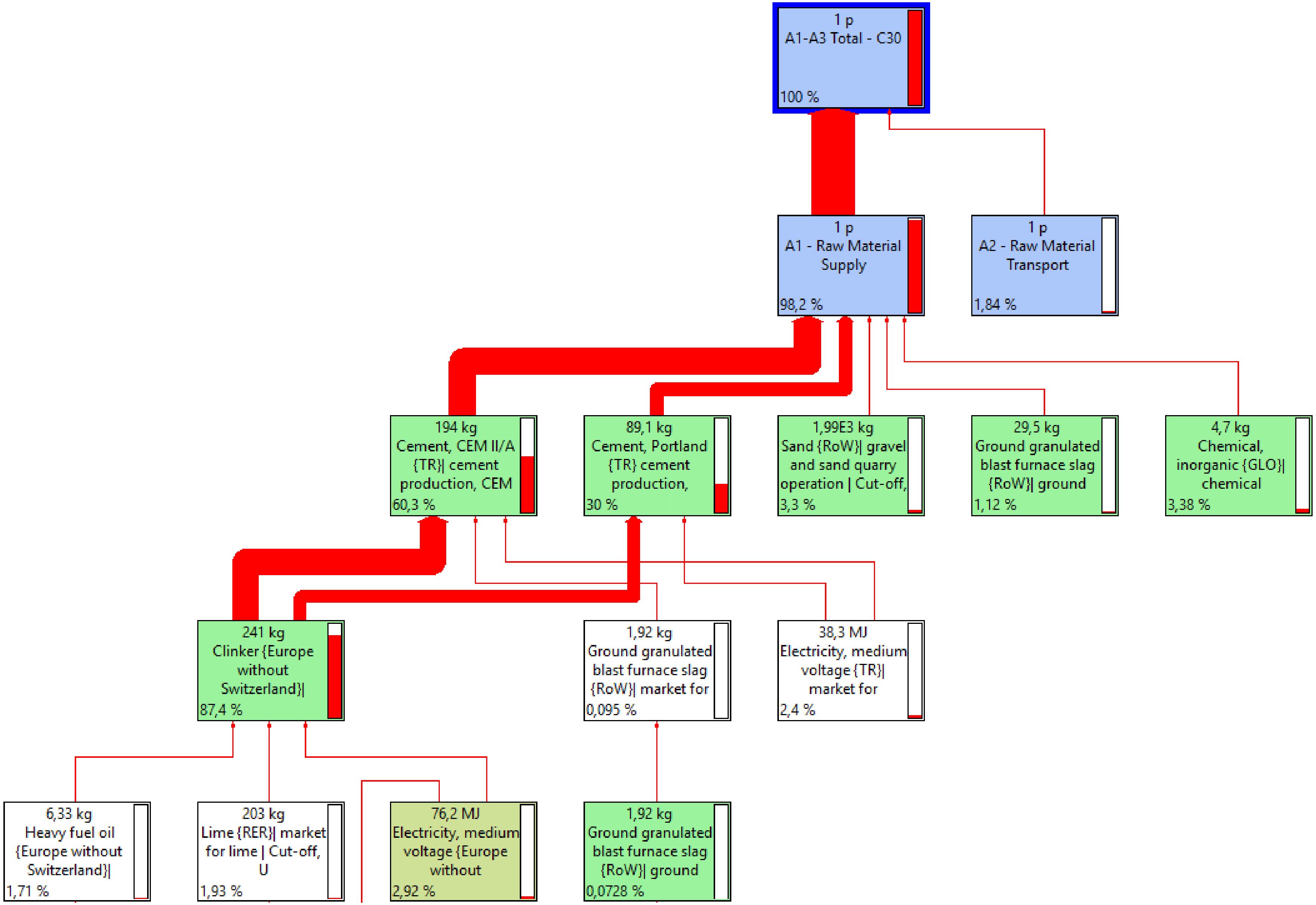

Figure 2: Carbon flow diagram of the product based on GWP-Fossil indicator for A1&A2&A3 stages

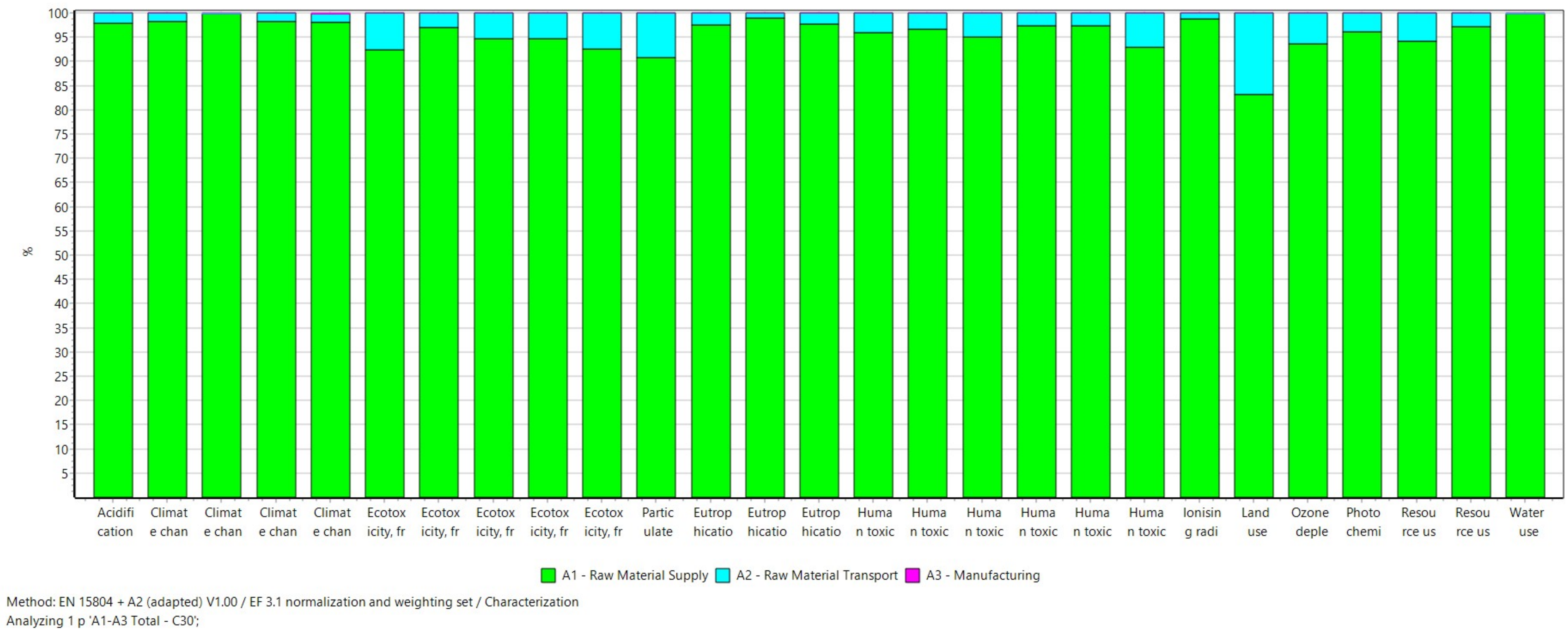

Figure 3: Impact assessment of A1&A2&A3 stages as percentage

Documentation of Additional Information

1.18 Documentation for calculating the Reference Service Life (RSL)

RSL is not relevant to this study.

References

GPI/ General Programme Instructions of the International EPD® System. Version 4.0.

EN ISO 9001/ Quality Management Systems - Requirements

EN ISO 14001/ Environmental Management Systems - Requirements

EN ISO 50001/ Energy Management Systems - Requirements

ISO 14020:2000/ Environmental Labels and Declarations — General principles

EN 15804:2012+A2:2019/ Sustainability of construction works - Environmental Product Declarations — Core rules for the product category of construction products

ISO 14025/ DIN EN ISO 14025:2009-11: Environmental labels and declarations - Type III environmental declarations — Principles and procedures

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