Results for building life cycle assessment

according to EN 15978

MSCP Stevenage Station

Address: SG1 1LZ, Stevenage UK

Assessor: Huber car park systems UK Ltd.

Client for assessment: Stevenage Borough Council

Date: 17.11.21

Contents

1. Purpose of the study and description of the building

Assessment basic information:

Purpose of the study:	Embodied carbon calculation / life-cycle-assessment
Project type:	New construction
Assessment method:	EN 15978:2011

Assessed building, general information:

Building type:	Multi storey car park (transport buildings)
Construction year:	2022
Building area:	4660m²
Extent of use:	622 parking bays in total
General service life:	50 years
Assessment period:	60 years

Building function(s) and service(s): Multi storey car park

Relevant technical and functional requirements:

The building is located next to Stevenage station and serves as multi storey car park for residents, commuters and visitors of Stevenage and proximity. It substitutes the existing surface car park and increases the number of parking bays significantly. 25% of these parking bays will be equipped with EV-chargers, with the possibility to increase this proportion to 75% in the future. The car park is open sided and naturally ventilated. Any mechanical ventilation is therefore not necessary. The structure is a free standing VCM with 6 storeys, including the ground floor. The building is served with two pre-cast stair cores at each end. Water supply is only required for regular cleaning purposes. A photovoltaic system will be installed on top of each stair core and the central ramp. This power will be used to accommodate the basic demand of the car park such as lighting, lift operation and any other small power. A battery storage facility will possibly support the power supply and contributes to the general self-supporting and sustainability of the building. The building is equipped with motion detectors and dimmable LEDs which reduces unnecessary lighting and light pollution during both night- and daytime. The structure largely consists of steel and mostly prefabricated items, which reduces operation time and waste on site. Because of the lightweight structure foundations can be

designed smaller and require less concrete and reinforcement. Any transports coming to site are loaded as efficiently and optimally as possible to reduce the amount of transport movements.

2. Life cycle impact assessment result summary

"Embodied carbon benchmarks are calculated for a fixed 60 year assessment period for all building materials, and do consider the given quantities of material, materials transports […] and material replacements required during the building assessment period as well as the end of life processing." (LCA, online)

5 309 Tons CO_2e 6.02 kg CO_2e / m^2 / year 265 452 £ Social cost of carbon

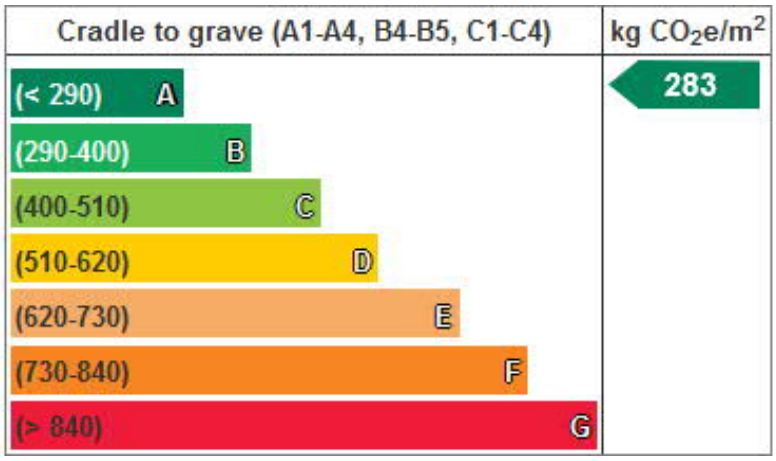

Figure 1: Embodied carbon benchmark (One click LCA, online)

The total carbon dioxide equivalent emissions are 5309 tons CO2e. This equals 6.02 kg CO2e per year and per building square meter. Taking an exemplary average price of 50 £/tCO2e into account this leads to a social cost of 265 452£ for the whole building life cycle.

The life cycle assessment is calculated using One Click LCA. The results are summarized in the following table. The results represent the total life cycle impact during 60-year service life.

Impact category	Unit	Results
Global warming potential (greenhouse gases)	$kgCO_2$ eq	5 309 042.49
Acidification potential	$kgSO_2$ eq	22 108.26
Eutrophication potential	$kgPO_4$-eq	4 056.78
Ozone depletion potential	$kgCFC_{11}eq$	0.38
Formation of ozone of lower atmosphere	kgC_2H_4eq	2 078.31
Non-hazardous waste disposed	kg	1 367 374.74
Biogenic carbon storage	kg CO_2 eq	3 941.42

Table 1:Life-cycle assessment results for BREEAM UK according to EN 15978 (One click LCA, online)

3. The life cycle assessment scope and system boundaries

In the assessment following life cycle stages according to EN 15804:2012 are included:

Product Stage			**Construction Process Stage**		**Use Stage**							**End-of-Life Stage**				**Benefits and loads beyond the system boundary**		
Raw material supply	Transport	Manufacturing	Transport to building site	Installation into building	Use/application	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction/demolitio	Transport	Waste processing	Disposal	Reuse	Recovery	Recycling
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D	D	D
x			x	x	x					x	x	x				x		

Table 2: Cradle to cradle (One click LCA)

Description of the life cycle stages and analysis scope are provided in the table below:

A1-A3 Construction Materials	Raw material supply (A1) includes emissions generated when raw materials are taken from nature, transported to industrial units for processing and processed. Loss of raw material and energy are also taken into account. Transport impacts (A2) include exhaust emissions resulting from the transport of all raw materials from suppliers to the manufacturer's production plant as well as impacts of production of fuels. Production impacts (A3) cover the manufacturing of the production materials and fuels used by machines, as well as handling of waste formed in the production processes at the manufacturer's production plants until end-of-waste state.
A4 Transportation to site	A4 includes exhaust emissions resulting from the transport of building products from manufacturer's production plant to building site as well as the environmental impacts of production of the used fuel.
A5 Construction/installation process	A5 covers the exhaust emissions resulting from using energy during the site operations, the environmental impacts of production processes of fuel and energy and water as well as handling of waste until the end-of-waste state.

B1-B5 Maintenance and material replacement	The environmental impacts of maintenance and material replacements (B1-B5) include environmental impacts from replacing building products after they reach the end of their service life. The emissions cover impacts from raw material supply, transportation and production of the replacing new material as well as the impacts from manufacturing the replacing material as well as handling of waste until the end-of-waste state.
B6 Energy use	The considered use phase energy consumption (B6) impacts include exhaust emissions from any building level energy production as well as the environmental impacts of production processes of fuel and externally produced energy. Energy transmission losses are also taken into account.
B7 Water use	The considered use phase water consumption (B7) impacts include the environmental impacts of production processes of fresh water and the impacts from waste water treatment.
C1-C4 Deconstruction	The impacts of deconstruction include impacts for processing recyclable construction waste flows for recycling (C3) until the end-of-waste stage or the impacts of pre-processing and landfilling for waste streams that cannot be recycled (C4) based on type of material. Additionally deconstruction impacts includes emissions caused by waste energy recovery.
D External impacts/end-of-life benefits	The external benefits include emission benefits from recycling recyclable building waste. Benefits for re-used or recycled material types include positive impact of replacing virgin based material with recycled material and benefits for materials that can be recovered for energy cover positive impact for replacing other energy streams based on average impacts of energy production.

Table 3: Description life cycle stages (One click LCA)

4. Assessed impact categories

Impact category	Unit	Description
Global warming potential (greenhouse gases)	$kgCO_2$ eq	Describes changes in local, regional, or global surface temperatures caused by an increased concentration of greenhouse gases in the atmosphere. Greenhouse gas emissions from fossil fuel burning has been strongly correlated with two other impact categories: acidification and smog. Often called “carbon footprint”.
Acidification potential	$kgSO_2$ eq	Describes the acidifying effect of substances in the environment. Substances such as carbon dioxide dissolve

		readily in water, increasing the acidity, which contributes to global phenomena such as ocean acidification (IPCC 2014).
Eutrophication potential	kgPO_4-eq	Describes the effect of adding mineral nutrients to soil or water, which causes certain species to dominate an ecosystem, compromising the survival of other species and sometimes resulting in die-off of populations.
Ozone depletion potential	kgCFC_{11}eq	Describes the effect of substances in the atmosphere to degrade the ozone layer, which absorbs and prevents harmful solar UV rays from reaching Earth's surface.
Formation of ozone of lower atmosphere	kgC_2H_4eq	Describes the effect of substances in the atmosphere to create photochemical smog. Also known as summer smog.
Non-hazardous waste disposed	kg	The amount of waste disposed that is arising from product raw material extraction, manufacturing and supply processes as well as end of life-processing
Biogenic carbon storage	kg CO2 eq	Biogenic carbon sequestered materials (in case of A1-A3) or in growing vegetation (in case of B1), expressed as CO2-equivalent. This biogenic carbon may or may not be preserved after the asset lifetime depending on the end of life process for said materials. This impact category is separate from accounting the fossil GWP.

Table 4: Assessed impact categories (One click LCA)

5. Analysis material scope

The LCA analysis included following building elements:

Element	Included	Comments
SUPERSTRUCTURE		
Frame	*Yes*	
Upper floors	*Yes*	
Roof	*Yes*	
Stairs	*Yes*	
External Walls	*Yes*	
Windows & External doors	*Yes*	
Internal Walls and Partitions	*Yes*	
Internal Doors	*No*	Only external doors
INTERNAL FINISHES		
Wall Finishes	*No*	N/A
Floor Finishes	*Yes*	

Ceiling Finishes	*Yes*	
BUILDING FITTINGS & FURNISHINGS		
Fixed fittings and equipment	*Yes*	
SERVICES		
Sanitary Fittings	*No*	N/A
Services Equipment	*Yes*	
Disposal Installations	*No*	N/A
Water Installations	*Yes*	
Heat Source	*No*	N/A
Space Heating and Air Treatment	*No*	N/A
Ventilation Systems	*No*	N/A
Electrical Installations	*Yes*	
Gas Installations	*No*	N/A
Lift Installations	*Yes*	
Protective Installations, inc. internal CCTV	*Yes*	
Communication Installations	*Yes*	
Specialist Installations	*Yes*	
EXTERNAL WORKS		
Site works	*Yes*	
Drainage	*Yes*	
External services	*Yes*	

Table 5: Material scope

6. Environmental data sources

One Click LCA LCA EN-15978 tool is used in the assessment. The tool supports CML (2002 - November 2012 or newer) methodology and all assessed impact categories. All of the datasets in the tool follow EN 15804 standard. A complete list of data sources is presented in attachment 1.

7. Project data sources and assumptions

The proposed building is calculated in One Click LCA based on design data from RIBA stage 3 and calculations.

Area of analysis	**Data sources**
Material quantities (A1-A3)	Project brief, architectural drawings and calculations
Building material transport distances (A4)	The case specific transport distances are used when available. Other transport distances are estimated based on typical average transport distances based on material type provided by calculation tool.

Construction and installation process (A5)	Calculation tool average construction process emissions based on project size are used in the analysis.
Material service life (B1-B5)	The service life information for each material is checked and project specific values are used when available. Otherwise default values from One Click LCA database are used.
Building use phase energy consumption (B6)	Energy consumption is based on project specific calculations.
Building use phase energy consumption (B7)	Water consumption is based on typical water consumption for car parks.

Table 6: Data sources and assumptions

Other assumptions:

It is assumed that the steel being used has no recycled content, which is a very conservative assumption and reflects a worst-case scenario. However, due to the unknown actual proportion of recycled material this seems to be reasonable. Taking this into account it can be assumed that the actual carbon emission of the whole car park is even less than calculated.

The energy consumption is calculated based on 75% EV-chargers with a diversity of 30%.

8. Detailed assessment results

Result summary

Section	Result category	Global warming kg CO2e	Acidification kg SO2e	Eutrophication kg PO4e	Ozone depletion potential kg CFC11e	Formation of ozone of lower atmosphere kg Ethenee	Non hazardous waste disposed kg	Biogenic carbon storage kg CO2e bio
A1-A3	Construction Materials	3,60E+06	1,13E+04	2,10E+03	1,40E-01	1,43E+03	8,72E+05	3,94E+03
A4	Transportation to site	9,30E+04	4,09E+02	8,90E+01	1,80E-02	5,89E+00	2,98E+02	
A5	Construction/installation process	1,45E+05	5,17E+02	3,11E+02	2,10E-02	1,79E+01	3,75E+04	
A5a	Site operations & site waste handling	1,45E+05	5,17E+02	3,11E+02	2,10E-02	1,79E+01	3,75E+04	
B4-B5	Material replacement and	4,94E+05	1,57E+03	3,23E+02	6,30E-03	1,98E+02	3,20E+05	
B4-B5a	Material replacement -	4,82E+05	1,54E+03	3,19E+02	5,80E-03	1,96E+02	1,31E+05	
B4-B5b	Material replacement -	2,55E+03	1,03E+01	2,22E+00	4,90E-04	2,10E-01	7,58E+00	
B4-B5c	Material replacement - waste	9,17E+03	1,69E+01	2,35E+00	3,00E-06	1,55E+00	1,89E+05	
B6	Energy use	8,95E+05	8,15E+03	1,20E+03	1,90E-01	4,17E+02	5,63E+04	
B7	Water use	2,16E+02	1,17E+00	5,90E-01	2,40E-05	5,30E-02	3,02E+01	
C1-C4	End of life	8,25E+04	1,47E+02	2,85E+01	1,70E-03	1,14E+01	8,16E+04	
C1-C4	Deconstruction	8,25E+04	1,47E+02	2,85E+01	1,70E-03	1,14E+01	8,16E+04	
D	External impacts (not included in	-1,56E+06	-7,81E+03	-1,84E+03	-1,10E-01	-9,61E+02	-4,59E+04	
D	Installed Materials - benefit	-1,26E+06	-5,27E+03	-1,48E+03	-5,80E-02	-8,25E+02	-4,44E+04	
B4-B5-benefit	Material replacement -	-3,55E+04	-1,89E+02	-1,51E+01	-1,00E-06	-1,45E+01	1,47E+04	
D2	Exported energy (not included in	-2,59E+05	-2,35E+03	-3,47E+02	-5,60E-02	-1,21E+02	-1,63E+04	

Figure 2: Results summary (One click LCA, online)

Global warming potential (GWP), kgCO2 eq

Describes changes in local, regional, or global surface temperatures caused by an increased concentration of greenhouse gases in the atmosphere. Greenhouse gas emissions from fossil fuel burning has been strongly correlated with two other impact categories: acidification and smog. Often called "carbon footprint".

Acidification potential (ADP), kgSO2 eq

Describes the acidifying effect of substances in the environment. Substances such as carbon dioxide dissolve readily in water, increasing the acidity, which contributes to global phenomena such as ocean acidification (IPCC 2014).

Eutrophication potential (EP) kgPO4-eq

Describes the effect of adding mineral nutrients to soil or water, which causes certain species to dominate an ecosystem, compromising the survival of other species and sometimes resulting in die-off of populations.

Ozone depletion potential (ODP), kgCFC11eq

Describes the effect of substances in the atmosphere to degrade the ozone layer, which absorbs and prevents harmful solar UV rays from reaching Earth's surface.

Formation of ozone of lower atmosphere (POCP), kgC2H4eq

Describes the effect of substances in the atmosphere to create photochemical smog. Also known as summer smog.

The major contributors for global warming potential emissions are A1-A3 materials followed by B6 Energy. This is reasonable due to the relatively low site operations in terms of demolitions and the high amount of material and energy used during construction and operation. Steel has the largest proportion in the A1-A3 material classification.

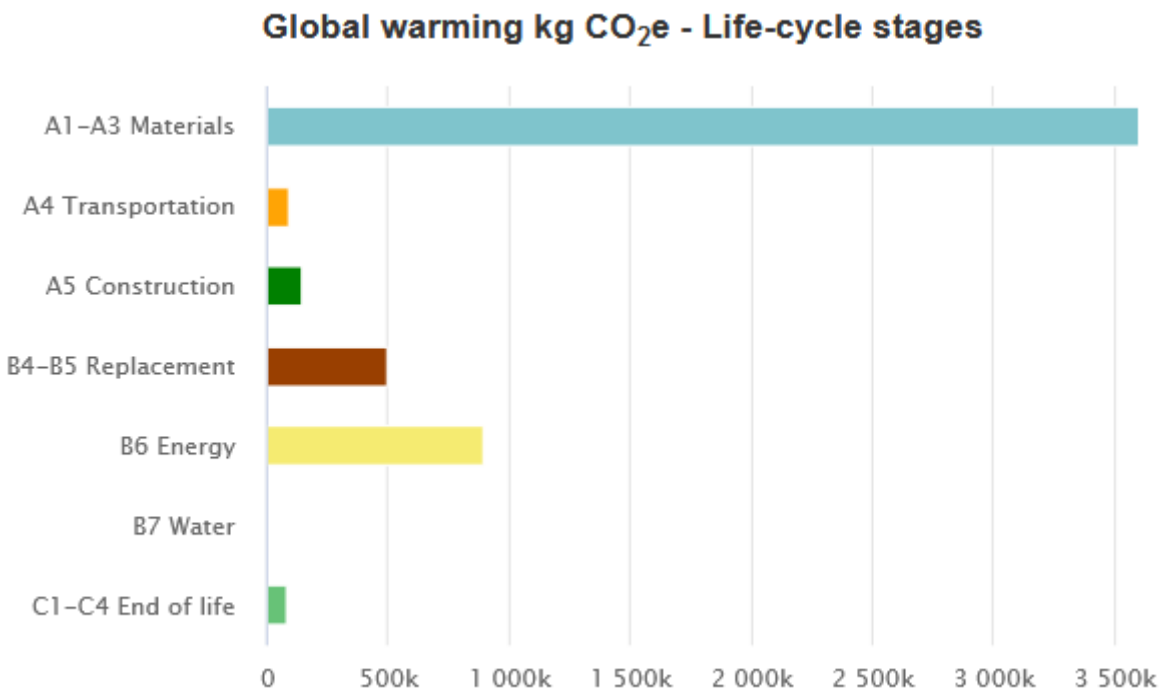

Figure 3: Global warming potential - Life cycle stages (One click LCA, online)

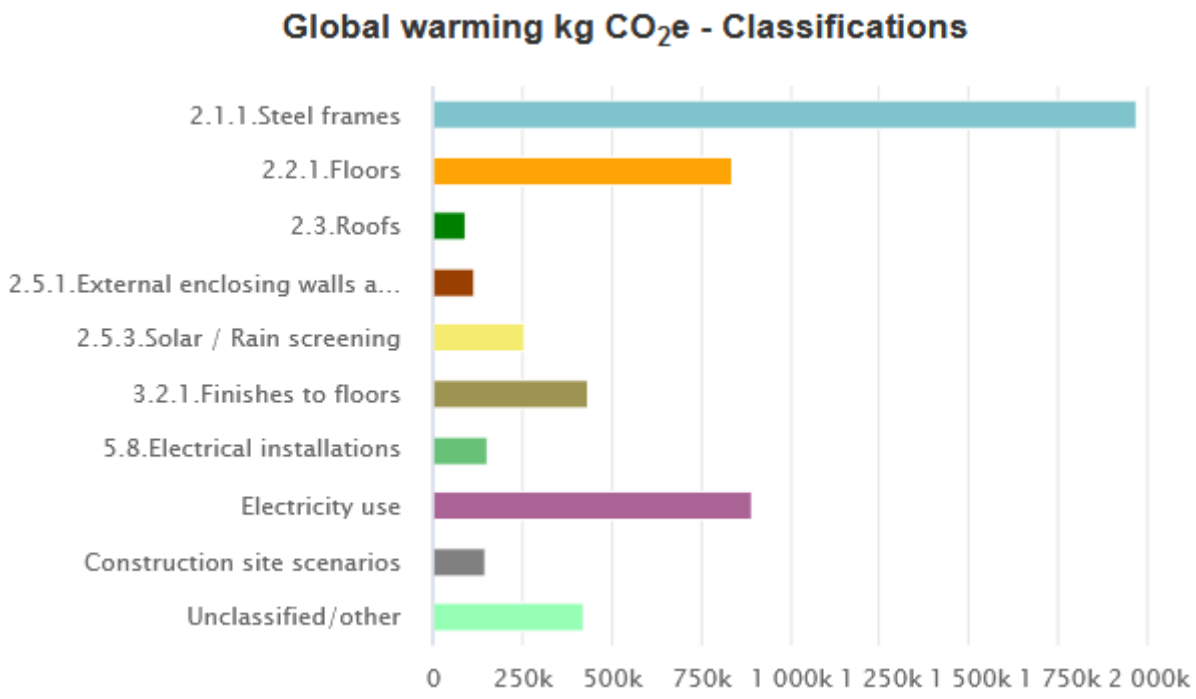

Figure 4: Global warming potential - Classifications (One click LCA, online)

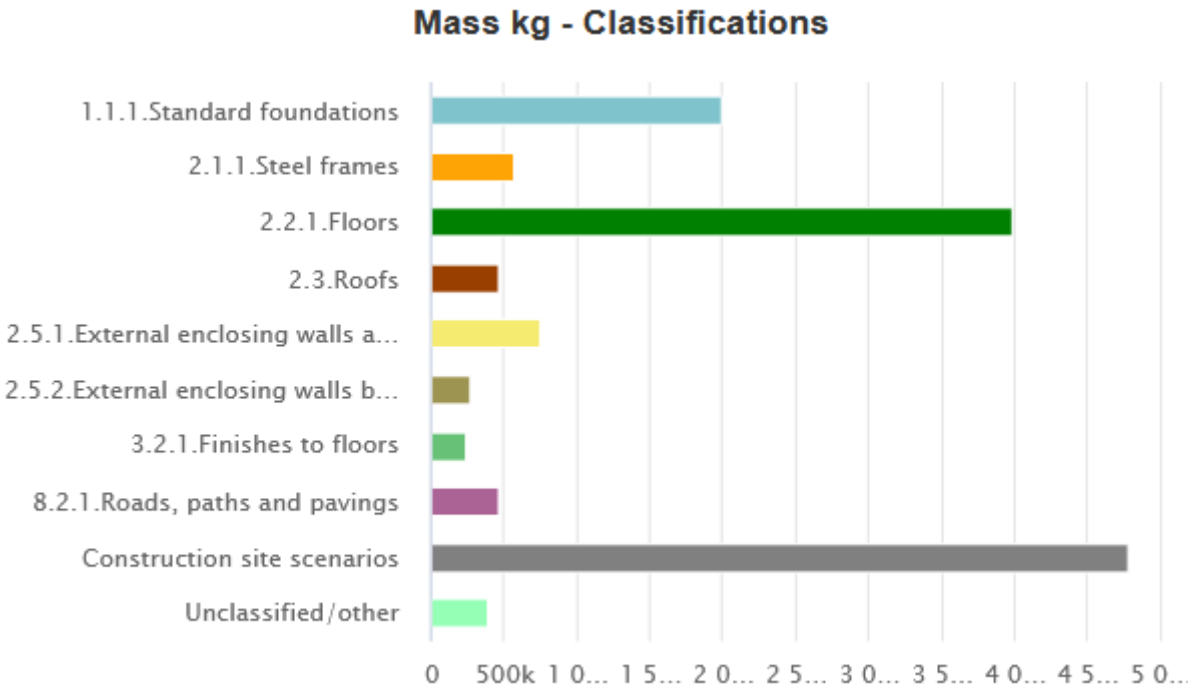

Figure 5: Mass kg - Classifications (One click LCA, online)

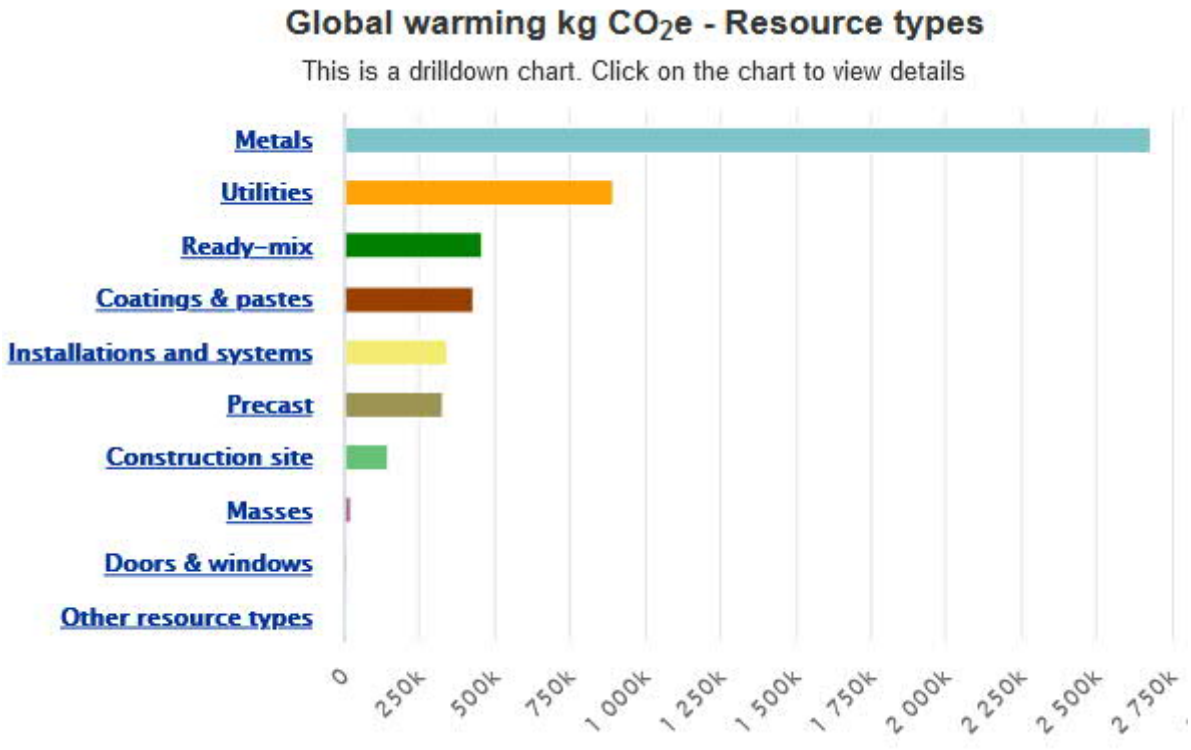

Figure 6:Global warming potential - Resource types (One click LCA, online)

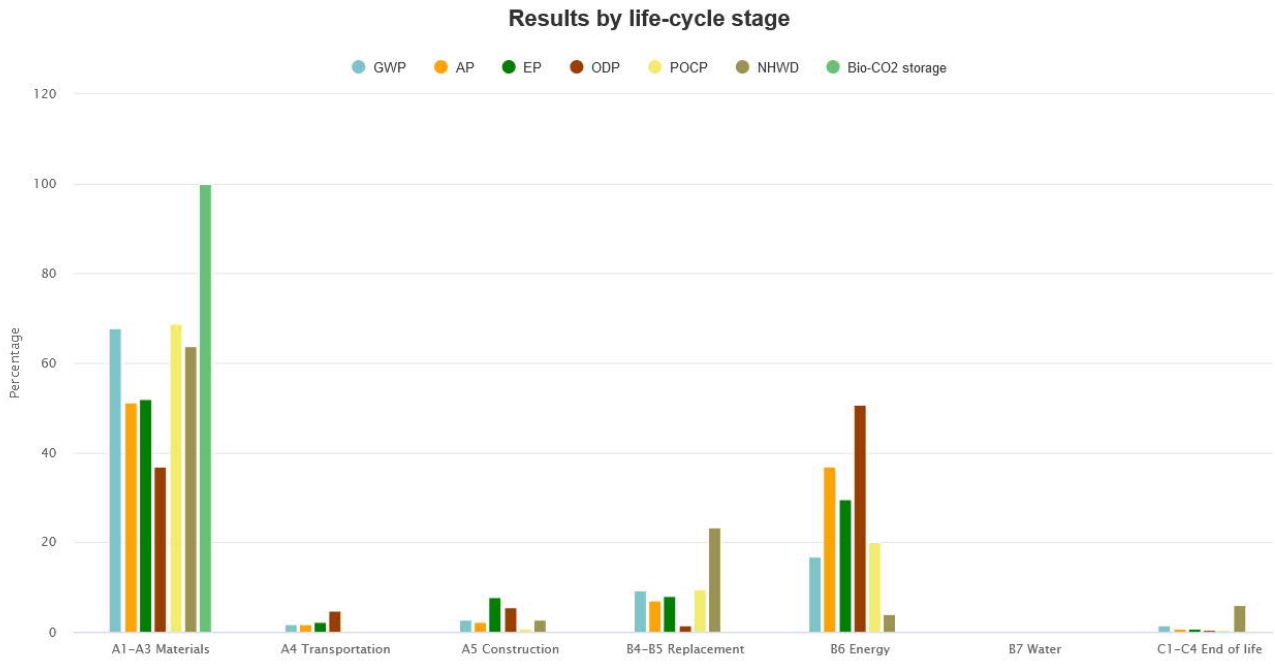

Figure 7: Results by life-cycle stage (One click LCA, online)

9. Description of One Click LCA calculation tool

The calculations are performed with One Click LCA calculation tool. The software is fully compliant with EN 15978 standard. One Click LCA has been third party verified by ITB for compliancy with the following LCA standards: EN 15978, ISO 21931–1 and ISO 21929, and data requirements of ISO 14040 and EN 15804. You can find the official letters of compliancy here: https://www.oneclicklca.com/wp-content/uploads/2016/11/360optimi-verification-ITB-Certificate-scanned-1.pdf.

ITB is a certification organization and a Notified Body (EC registration nr. 1488) to the European Commission designated for construction product certification. Polish Accreditation Board assures the independence and impartiality of ITB services (Accreditation Certificates are: AB 023, AC 020, AC 072, AP 113). ITB activities are conducted in accordance to the requirements of the following assurance standards: ISO 9001, ISO/IEC 27001, ISO/IEC 17025, EN 45011, and ISO/IEC 17021.

List of Figures

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Attachment 1 - Sources

Resource name	Date	Environment Data Source	Standard	EPD program	PCR	Notes about PCR	Upstream DB	Verification
Aluminium window system, triple glazed, per unit	2018	EPD Schüco AWS 75.SI+ W x H: 1836 mm x 3730 mm for project: S7 III - Item: TP-03 Schüco International KG	EN15804+A1	IBU	PCR Windows and doors, 11/2015	Only with EN15804	GaBi	Third-party verified (as per ISO 14025)
Cable trunking/channels, aluminium	2016	PEP	PEP	INIES	EN15804+A1	-	ecoinvent	Third-party verified (as per ISO 14025)
Cement mortar	2020	Oekobau.dat 2020-II	EN15804+A1	OKOBAUDAT	EN15804+A1	-	GaBi	Third-party verified (as per ISO 14025)
Circuit breaker	2016	PEP	PEP	INIES	EN15804+A1	-	ecoinvent	Third-party verified (as per ISO 14025)
Cold formed steel sheet piles	2019	EPD Cold formed steel sheet piles ArcelorMittal	EN15804+A1	IBU	PCR Structural steels, 07.2014	Only with EN15804	GaBi	Third-party verified (as per ISO 14025)
Electricity cabling, room area m2	2013	One Click LCA	ISO14040	One Click LCA	-	Only with EN15804	ecoinvent	Internally verified
Electricity, United Kingdom	2015	SAP 10.0 / One Click LCA		One Click LCA			ecoinvent	Internally verified
Elevator, 630 kg capacity, for passenger use	2020	KONE MonoSpace® 500 DX	EN15804+A1	RTS	RTS PCR 14.6.2018 RTS PCR protocol: EPDs published by the Building Information Foundation RTS sr. PT 18 RT EPD Committee.	Only with EN15804	ecoinvent	Third-party verified (as per ISO 14025)

					(English version)			
Footing foundations for hard soils (sand, gravel, silt or clay) per GFA		One Click LCA generic construction definitions		One Click LCA			Ecoinvent	
Geotextile, generic	2018	One Click LCA	EN15804+A1	One Click LCA	EN15804+A1	-	ecoinvent	Internally verified
Granular surfacing ø 8...20 mm, 35 kg/m²	2016	LCA of crushed stone, OneClickLCA 2016	ISO14040	One Click LCA	-	Only with EN15804	ecoinvent	Internally verified
Hot dip galvanized steel	2020	Oekobau.dat 2020-II	EN15804+A1	OKOBAUDAT	EN15804+A1	-	GaBi	Third-party verified (as per ISO 14025)
Hot-dip galvanized structural steel	2013	Oekobau.dat 2017-I, EPD Feuerverzinkte Baustähle: Offene Walzprofile und Grobbleche bauforumstahl e.V. & Industrieverband Feuerverzinken e.V.	EN15804+A1	IBU	PCR Baustähle, 07/2012	-	GaBi	Third-party verified (as per ISO 14025)