



EU Level(s) Pilots – Austria

Learnings from LCA studies

Dominik Maierhofer, Silke Scherhag, Martin Röck, Alexander Passer

12.09.2019

Level(s) Team, Graz University of Technology



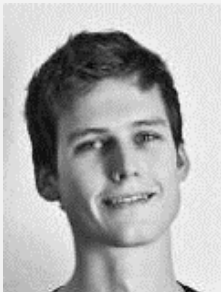
Alexander Passer

Assoc.Prof. Dipl.-Ing. Dr.techn. MSc
Arbeitsgruppe Nachhaltiges Bauen
Wagner-Biro-Straße 100/XI
8020 Graz
+43 (316) 873 - 7153
alexander.passer@tugraz.at



Silke Scherhag

silke.scherhag@student.tugraz.at



Martin Röck

Dipl.-Ing. BSc
Arbeitsgruppe Nachhaltiges Bauen
Wagner-Biro-Straße 100/XI
8020 Graz
+43 (316) 873 - 7652
martin.roeck@tugraz.at



Dominik Maierhofer

BSc
Arbeitsgruppe Nachhaltiges Bauen
Wagner-Biro-Straße 100/XI
8020 Graz
+43 (316) 873 - 7654
dominik.maierhofer@tugraz.at

Case Studies

be2226



Source: BaumschlagerEberle Architects

Architects: Baumschlager & Eberle
Client: AD Vermietung OG
Construction year: 2013
Context: suburban (Millennium Park, Lustenau)
Net floor area: 2,700 m²
Heating demand: 8 W/m² (covered by waste heat from users and appliances)
Represents: advanced building concept (passive, no heating/cooling)

Science Tower



Source: DI Markus Pernthaler Architektur ZT GmbH

Architect: DI Markus Pernthaler
Use: office
Construction year: 2017
Floors: 2 underground floors, 14 upper floors
Context: urban (near Main Railway Station Graz)
Total gross floor area: 4,174 m²
Skeleton construction: Reinforced Concrete Supports and ceilings, external building envelope
Standard storeys: External walls made of wood module system with room-high windows (curtain wall)

BIM-based LCA

be2226



Source: BaumschlagerEberle Architects

Architects: Baumschlager & Eberle

Client: AD Vermietung OG

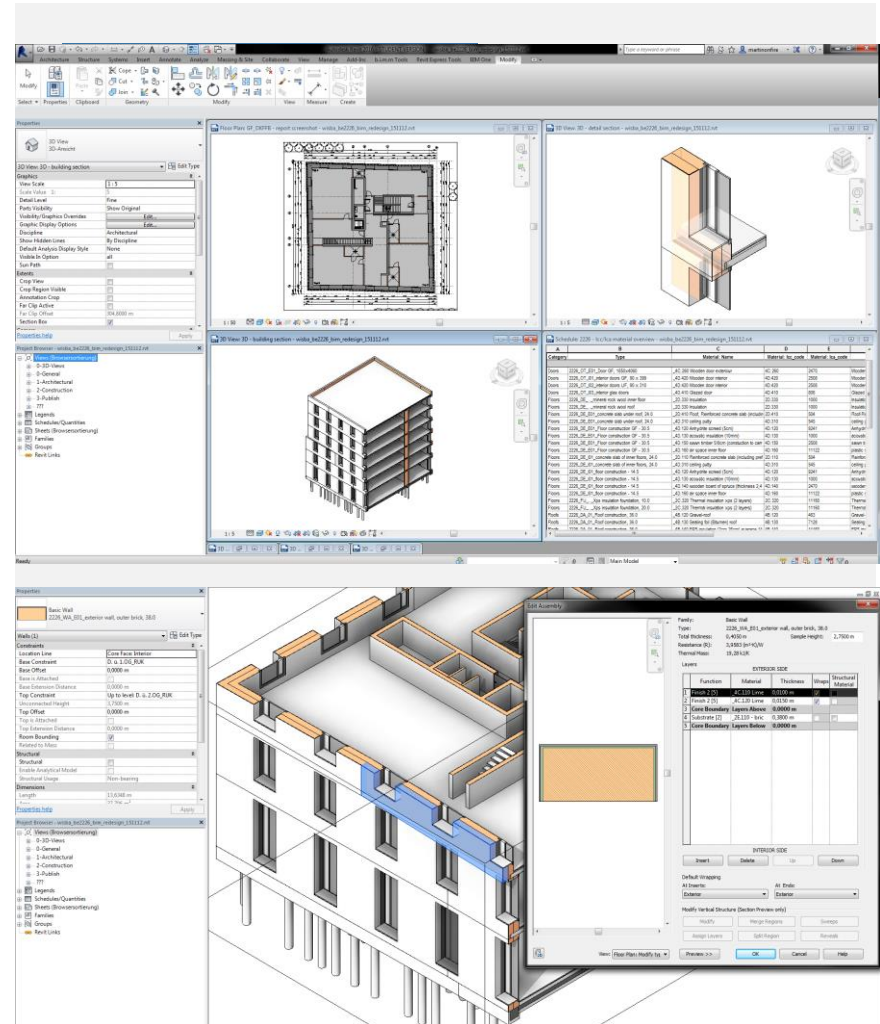
Construction year: 2013

Context: suburban (Millennium Park, Lustenau)

Net floor area: 2,700 m²

Heating demand: 8 W/m² (covered by waste heat from users and appliances)


















Represents: advanced building concept (passive, no heating/cooling)



System Boundaries - Elements

Building parts	Related building elements	Included be2226	Included SCT
Shell (substructure and superstructure)		yes / no / n.a.	yes / no / n.a.
Foundation_Substructure	Piles	yes	yes
	Basements	yes	yes
	Retaining walls	yes	yes
Load_bearing_structural_frame	Frame (beams, columns and slabs)	yes	yes
	Upper floors	yes	yes
	External walls	yes	yes
Non_load_bearing_elements	Balconies	n.a.	n.a.
	Ground floor slab	yes	yes
	Internal walls, partitions and doors	yes	yes
Facades	Stairs and ramps	yes	yes
	External wall systems, cladding and shading devices	yes	yes
	Façade openings (including windows and external doors)	yes	yes
Roof	External paints, coatings and renders	yes	yes
	Structure	yes	yes
	Weatherproofing	yes	yes
Parking_facilities	Above ground and underground (within the curtilage of the building and servicing the building occupiers)	n.a.	n.a.
Core (fittings, furnishings and services)			
Fittings_and_furnishings	Sanitary fittings	yes	yes
	Cupboards, wardrobes and worktops (where provided in residential property)	yes	no
	Ceilings	yes	yes
	Wall and ceiling finishes	yes	yes
	Floor coverings and finishes	yes	yes
In_built_lighting_system	Light fittings	yes	no
	Control systems and sensors	yes	no
Energy_system	Heating plant and distribution	n.a.	no
	Cooling plant and distribution	n.a.	no
	Electricity generation and distribution	yes	no
Ventilation_system	Air handling units	n.a.	no
	Ductwork and distribution	n.a.	no
Sanitary_systems	Cold water distribution	yes	no
	Hot water distribution	yes	no
	Water treatment systems	n.a.	no
	Drainage system	yes	no
Other_systems	Lifts and escalators	yes	no
	Firefighting installations	yes	no
	Communication and security installations	yes	no
	Telecoms and data installations	yes	no
External works			
Utilities	Connections and diversions	no	no
	Substations and equipment	no	no
Landscaping	Paving and other hard surfacing	no	no
	Fencing, railings and walls	no	no
	Drainage systems	no	no

Indicators – Tools and Data – be2226

Indicator / Tools	Tool	Data
Indicator 1.1 Use stage energy performance: - 1.1.1 Primary energy demand - 1.1.2 Delivered energy demand	 SimaPro SimaPro	 Input Architects  Ecoinvent 3.4
Indicator 1.2 Life cycle Global Warming Potential	 SimaPro SimaPro	 Ecoinvent 3.4
Tool 2.1 Life cycle tools: Building bill of materials		 BIM Model be2226 taken from the PEF4Buildings Project
Tool 2.2 - Scenario 1 Building and elemental service life planning		 DGNB System - Version 2018, VDI-Richtlinien VDI 2067, BNB Nutzungsdauern von Bauteilen
Tool 2.2 - Scenario 2 Design for adaptability and refurbishment	 Indicator Eco 2.1	 DGNB - Core 2014
Tool 2.2 - Scenario 3 Design for deconstruction, reuse and recyclability	 ÖGNI Tec 1.6 - Tool	 ÖGNI - Version 2017
Indicator 2.3 Construction and demolition waste		 OVAM - Environmental profile of building elements,  Austrian Economic Chamber - Guide to the correct handling of construction waste on construction sites
Indicator 2.4 LCA Overarching assessment tool: Cradle to cradle Life Cycle Assessment (LCA)	 SimaPro Simapro	 Ecoinvent 3.4
Indicator 3.1 Total water consumption	 Level(s) - Water Calculation Tool	 Input Architect

Life cycle tool 2.1 – Results be2226

Conducted Steps:

- Export of quantities from the BIM model
- Classification of used materials according to the element method
- Allocation of components in level(s) components
- Allocation of components in level(s) components
- Assignment of components in level(s) of assigned components
- Allocation of individual materials to Eurostat materials

Material type	Mass (t)
Metal	88,44
Non-metallic mineral	4605,32
Biomass	73,35
Fossil energy	14,13
TOTAL	4781,24

Building element (substructure and superstructure)	Building parts	Related building elements	Bill of Quantities (units)	Bill of Materials by material type (kg)				
				Metal	Non-metallic mineral	Biomass	Fossil energy	TOTAL
Shell	Foundation_Substructure	Piles	180,72 m ³	14186,52	411499,44	0,00	0,00	425685,96
Shell	Foundation_Substructure	Basements	191,63 m ³	15042,96	436341,51	0,00	0,00	451384,47
Shell	Load_bearing_structural_frame	Upper floors	2493,99 m ²	46986,77	1422172,86	0,00	0,00	1469159,63
Shell	Load_bearing_structural_frame	External walls	1548,57 m ²	0,00	470559,32	0,00	0,00	470559,32
Shell	Non_load_bearing_elements	Internal walls, partitions and doors	1947,28 m ²	0,00	402543,71	0,00	0,00	402543,71
Shell	Non_load_bearing_elements	Internal walls, partitions and doors	34 pcs	45,25	2343,60	1003,98	0,00	3392,84
Shell	Non_load_bearing_elements	Stairs and ramps	14,31 m ³	0,00	30576,00	863,50	0,00	31439,50
Shell	Facades	External wall systems, cladding and shading devices	1799,26 m ²	0,00	554237,27	0,00	4459,35	558696,62
Shell	Facades	Façade openings (including windows and external doors)	120 pcs	0,00	10855,13	17293,19	528,46	28676,78
Shell	Facades	External paints, coatings and renders	1645,63 m ²	0,00	74053,35	0,00	0,00	74053,35
Shell	Roof	Strucutre	498,31 m ²	9388,16	284156,29	0,00	0,00	293544,45
Shell	Roof	Weatherproofing	525,98 m ²	0,00	89416,60	0,00	8463,02	97879,62
Core	Fittings_and_furnishings	Sanitary fittings	12 pcs	0,00	162,00	0,00	0,00	162,00
Core	Fittings_and_furnishings	Wall and ceiling finishes	4426,58 m ²	0,00	142829,88	0,00	0,00	142829,88
Core	Fittings_and_furnishings	Floor coverings and finishes	2726,21 m ²	0,00	273575,17	54188,72	654,29	328418,19
Core	Other_systems	Lifts and escalators	1 pcs	2792,00	0,00	0,00	22,00	2814,00

Indicator 2.4 – Results be2226

Conducted Steps:

- Rating on Level 2
- Modelling of stages A1-A3, A4, A5, B4, B5, B6, B7, C1, C2, C3-C4 in SimaPro
- Percentage share calculation of Stages B1, B2, B3
- Evaluation of the results using an Excel evaluation tool
- Entry of the results in the report tool
- Calculation of Data quality index
- Sensitivity analysis
- Critical analysis and reporting

Environmental Impacts for each life cycle stage							
Scenario	Indicator	Unit	Product (A1-3)	Construction process (A4-5)	Use stage (B1-7)	End of life (C1-4)	Benefits and loads beyond the system boundary (D)
SI1: be2226 as constructed - results in [Unit]/m ² a, reference study period of 60 years	Global Warming Potential (GWP)	kg CO ₂ eq	6,47E+00	7,78E-01	2,50E+01	1,14E+00	not assessed
	Depletion potential of the stratospheric ozone layer (ODP)	kg CFC11 eq	4,43E-07	1,77E-07	2,13E-06	1,31E-07	not assessed
	Acidification Potential of land and water (AP)	kg SO ₂ eq	1,91E-02	3,08E-03	6,00E-02	3,49E-03	not assessed
	Eutrophication Potential (EP)	kg (PO ₄) ₃ eq	2,60E-03	5,48E-04	1,23E-02	7,07E-04	not assessed
	Formation potential of tropospheric ozone photochemical oxidants (POCP)	kg C ₂ H ₄ eq	1,36E-03	1,33E-04	3,39E-03	1,15E-04	not assessed
	ADP elements	kg Sb eq	2,72E-05	2,05E-06	5,10E-05	9,11E-07	not assessed
	ADP fossil fuels	MJ (LHV)	5,52E+01	1,21E+01	2,56E+02	9,14E+00	not assessed
	Use of renewable primary energy resources used as raw material	MJ	0,000	0,000	0,000	0,000	not assessed
	Use of non-metallic mineral resources	kg	31,704	0,000	1,201	0,000	not assessed

Indicator 2.4 – Results be2226

Detailed Stages

Global Warming Potential (GWP)

Method: IPCC 2013 GWP 100a V1.03 based on EN 15804

Unit: varies

be2226 - absolute impact in each module

Impact Category	Unit	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3-C4
Global Warming Potential (GWP)	kg CO ₂ eq	6,47E+00	6,30E-01	1,48E-01		2,65E-01		2,23E+00	0,00E+00	2,25E+01	6,11E-03	1,15E-01	1,83E-01	8,38E-01
Depletion potential of the stratospheric ozone layer (ODP)	kg CFC11 eq	4,43E-07	1,45E-07	3,15E-08		2,15E-08		1,15E-07	0,00E+00	1,99E-06	9,78E-10	1,78E-08	4,25E-08	7,03E-08
Acidification Potential of land and water (AP)	kg SO ₂ eq	1,91E-02	2,01E-03	1,07E-03		1,29E-03		6,62E-03	0,00E+00	5,21E-02	2,71E-05	8,72E-04	5,84E-04	2,03E-03
Eutrophication Potential (EP)	kg (PO ₄) ₃ eq	2,60E-03	3,26E-04	2,22E-04		1,94E-04		8,67E-04	0,00E+00	1,12E-02	3,41E-06	1,87E-04	9,53E-05	4,25E-04
Formation potential of tropospheric ozone photochemical oxidants (POCP)	kg C ₂ H ₄ eq	1,36E-03	1,03E-04	2,96E-05		6,05E-05		4,08E-04	0,00E+00	2,92E-03	2,51E-06	2,24E-05	2,99E-05	6,29E-05
ADP elements	kg Sb eq	2,72E-05	2,00E-06	4,49E-08		1,01E-06		1,95E-05	0,00E+00	3,04E-05	3,65E-08	2,43E-08	5,47E-07	3,40E-07
ADP fossil fuels	MJ (LHV)	5,52E+01	9,92E+00	2,19E+00		4,16E+00		1,76E+01	0,00E+00	2,34E+02	7,02E-02	1,68E+00	2,90E+00	4,57E+00

be2226 - relative impact in each module

Impact Category	Unit	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3-C4
Global Warming Potential (GWP)	kg CO ₂ eq	19,34%	1,88%	0,44%		0,79%		6,66%	0,00%	67,46%	0,02%	0,34%	0,55%	2,51%
Depletion potential of the stratospheric ozone layer (ODP)	kg CFC11 eq	15,39%	5,03%	1,09%		0,75%		3,97%	0,00%	69,20%	0,03%	0,62%	1,47%	2,44%
Acidification Potential of land and water (AP)	kg SO ₂ eq	22,25%	2,34%	1,25%		1,51%		7,73%	0,00%	60,82%	0,03%	1,02%	0,68%	2,37%
Eutrophication Potential (EP)	kg (PO ₄) ₃ eq	16,09%	2,02%	1,38%		1,20%		5,37%	0,00%	69,54%	0,02%	1,16%	0,59%	2,63%
Formation potential of tropospheric ozone photochemical oxidants (POCP)	kg C ₂ H ₄ eq	27,22%	2,07%	0,59%		1,21%		8,16%	0,00%	58,39%	0,05%	0,45%	0,60%	1,26%
ADP elements	kg Sb eq	33,51%	2,47%	0,06%		1,25%		24,08%	0,00%	37,46%	0,05%	0,03%	0,67%	0,42%
ADP fossil fuels	MJ (LHV)	16,60%	2,98%	0,66%		1,25%		5,30%	0,00%	70,43%	0,02%	0,50%	0,87%	1,37%

Environmental Hotspots

Whole life cycle

Global Warming Potential (GWP)

Method: IPCC 2013 GWP 100a V1.03 based on EN 15804

Unit: varies

Life Cycle Stages - Sum of whole Life Cycle per m² and year

be2226 Operation	Global Warming Potential		Depletion potential of the stratospheric ozone layer (ODP)		Acidification Potential of land and water (AP)		Eutrophication Potential (EP)		Formation potential of tropospheric ozone photochemical oxidants (POCP)		ADP elements		ADP fossil fuels	
	[kg CO2 eq]	[%]	[kg CFC11 eq]	[%]	[kg SO2 eq]	[%]	[kg (PO4)3 eq]	[%]	[kg C2H4 eq]	[%]	[kg Sb eq / m ²]	[%]	[MJ (LHV)]	[%]
be2226 Material														
Sum	3,34E+01	100,00%	2,88E-06	100,00%	8,57E-02	100,00%	1,61E-02	100,00%	5,00E-03	100,00%	8,11E-05	100,00%	3,32E+02	100,00%
Operation_Energy	2,25E+01	67,46%	1,99E-06	69,20%	5,21E-02	60,82%	1,12E-02	69,54%	2,92E-03	58,39%	3,04E-05	37,44%	2,34E+02	70,43%
Operation_Water	6,11E-03	0,02%	9,78E-10	0,03%	2,71E-05	0,03%	3,41E-06	0,02%	2,51E-06	0,05%	3,65E-08	0,05%	7,02E-02	0,02%
Operation_Maintenance	2,65E-01	0,79%	2,15E-08	0,75%	1,29E-03	1,51%	1,94E-04	1,20%	6,05E-05	1,21%	1,02E-06	1,25%	4,16E+00	1,25%
Construction_Process	1,48E-01	0,44%	3,15E-08	1,09%	1,07E-03	1,25%	2,22E-04	1,38%	2,96E-05	0,59%	4,49E-08	0,06%	2,19E+00	0,66%
ConcreteFoundation	8,39E-01	2,51%	6,26E-08	2,17%	2,05E-03	2,39%	3,52E-04	2,18%	1,03E-04	2,06%	9,47E-07	1,17%	5,20E+00	1,57%
ConcreteInSitu	1,29E+00	3,85%	1,19E-07	4,13%	3,55E-03	4,15%	6,14E-04	3,80%	1,67E-04	3,35%	1,80E-06	2,22%	9,74E+00	2,93%
ReinforcingSteel	3,34E-01	1,00%	4,62E-08	1,60%	1,64E-03	1,92%	2,44E-04	1,51%	1,07E-04	2,15%	8,40E-07	1,04%	4,61E+00	1,39%
XPS	1,38E+00	4,13%	1,50E-08	0,52%	1,91E-03	2,23%	1,94E-04	1,20%	2,11E-04	4,23%	3,76E-07	0,46%	1,18E+01	3,56%
LimePlaster	2,25E+00	6,72%	1,26E-07	4,36%	4,92E-03	5,74%	6,37E-04	3,95%	2,29E-04	4,58%	8,89E-07	1,10%	1,32E+01	3,98%
Brick	2,29E+00	6,86%	2,55E-07	8,84%	6,27E-03	7,32%	9,06E-04	5,61%	4,21E-04	8,43%	4,84E-06	5,97%	2,37E+01	7,12%
CementMortar	3,37E-01	1,01%	2,18E-08	0,76%	9,40E-04	1,10%	1,31E-04	0,81%	4,89E-05	0,98%	2,71E-07	0,33%	2,03E+00	0,61%
ConcretePrefab	2,67E-02	0,08%	2,65E-09	0,09%	8,22E-05	0,10%	1,37E-05	0,09%	4,23E-06	0,08%	4,17E-08	0,05%	2,27E-01	0,07%
SawnTimber	1,79E-02	0,05%	3,45E-09	0,12%	1,21E-04	0,14%	2,88E-05	0,18%	3,10E-05	0,62%	4,59E-08	0,06%	2,39E-01	0,07%
AnhydriteFloor	1,94E-01	0,58%	3,02E-08	1,05%	1,09E-03	1,28%	1,41E-04	0,87%	5,39E-05	1,08%	4,39E-07	0,54%	2,81E+00	0,84%
PVCfoil	3,54E-02	0,11%	2,01E-09	0,07%	5,67E-05	0,07%	7,18E-06	0,04%	3,28E-06	0,07%	1,73E-08	0,02%	3,51E-01	0,11%
Rockwool	8,15E-03	0,02%	6,18E-10	0,02%	6,39E-05	0,07%	5,43E-06	0,03%	3,99E-06	0,08%	1,77E-08	0,02%	9,76E-02	0,03%
Double flooring system	8,10E-03	0,02%	6,34E-10	0,02%	2,87E-05	0,03%	3,60E-06	0,02%	2,07E-06	0,04%	1,47E-08	0,02%	1,18E-01	0,04%
Plywood	3,42E-01	1,02%	5,81E-08	2,02%	1,80E-03	2,10%	2,97E-04	1,84%	1,99E-04	3,99%	1,51E-06	1,86%	5,20E+00	1,56%
EPDM	5,67E-02	0,17%	8,17E-10	0,03%	9,16E-05	0,11%	7,94E-06	0,05%	5,23E-06	0,10%	1,03E-08	0,01%	9,87E-01	0,30%
Gravel	1,98E-02	0,06%	4,51E-09	0,16%	8,40E-05	0,10%	1,53E-05	0,10%	3,68E-06	0,07%	9,78E-08	0,12%	3,05E-01	0,09%
GlazingTriple	6,11E-01	1,83%	5,10E-08	1,77%	3,93E-03	4,58%	3,96E-04	2,45%	2,18E-04	4,36%	9,11E-06	11,23%	6,63E+00	1,99%
FrameWood	2,60E-01	0,78%	1,96E-08	0,68%	1,47E-03	1,72%	1,78E-04	1,10%	1,07E-04	2,15%	8,33E-06	10,27%	2,79E+00	0,84%
VacuumInsulationPanel														
DoorFrame														
GlazingDouble	6,51E-02	0,19%	7,77E-09	0,27%	4,74E-04	0,55%	4,12E-05	0,26%	1,95E-05	0,39%	2,25E-07	0,28%	7,08E-01	0,21%
SanitaryCeramics	2,56E-03	0,01%	3,83E-10	0,01%	7,55E-06	0,01%	1,06E-06	0,01%	5,01E-07	0,01%	1,29E-08	0,02%	3,53E-02	0,01%
Aluminium	1,50E-03	0,00%	6,66E-11	0,00%	8,06E-06	0,01%	7,16E-07	0,00%	4,98E-07	0,01%	7,39E-08	0,09%	1,40E-02	0,00%
Cast Iron	2,66E-02	0,08%	1,62E-09	0,06%	1,10E-04	0,13%	1,18E-05	0,07%	1,61E-05	0,32%	1,90E-08	0,02%	2,87E-01	0,09%
Copper	6,72E-04	0,00%	6,20E-11	0,00%	2,26E-05	0,03%	1,72E-05	0,11%	8,18E-07	0,02%	5,99E-07	0,74%	7,53E-03	0,00%
Steel	1,06E-02	0,03%	1,21E-09	0,04%	5,02E-05	0,06%	6,52E-06	0,04%	3,72E-06	0,07%	6,44E-08	0,08%	1,40E-01	0,04%
Polyethylene	2,34E-03	0,01%	5,25E-12	0,00%	1,93E-06	0,00%	1,72E-07	0,00%	1,04E-07	0,00%	9,75E-11	0,00%	2,15E-02	0,01%
Electronics	5,48E-02	0,16%	3,87E-09	0,13%	4,07E-04	0,47%	2,48E-04	1,54%	2,48E-05	0,50%	1,90E-05	23,49%	6,03E-01	0,18%

Environmental hotspots

Level(s) building elements

Global Warming Potential (GWP)

Method: IPCC 2013 GWP 100a V1.03 based on EN 15804

Unit: kg CO2 eq

Level(s) Buildingparts	Level(s) Elements	Life Cycle Stages - Overview							
		Product (A1-3)		Construction process (A4-5)		Use stage (B1-7)		End of life (C1-4)	
		Sum [kg CO2 eq]	[%]	Sum [kg CO2 eq]	[%]	Sum [kg CO2 eq]	[%]	Sum [kg CO2 eq]	[%]
Foundation Substructure	Piles	3,53E-01	3%	5,19E-02	0%			5,76E-02	1%
	Basements	3,74E-01	4%	5,50E-02	1%			6,11E-02	1%
	Retaining walls								
Load bearing structural frame	Frame (beams, columns and slabs)								
	Upper floors	8,81E-01	8%	1,78E-01	2%			1,97E-01	2%
	External walls	6,75E-01	6%	2,19E-02	0%			3,94E-02	0%
Non load bearing elements	Balconies								
	Ground floor slab								
	Internal walls, partitions and doors	7,32E-01	7%	2,57E-02	0%	4,78E-02	0%	4,44E-02	0%
Facades	Stairs and ramps	1,92E-02	0%	3,90E-03	0%			4,38E-03	0%
	External wall systems, cladding and shading devices	1,15E+00	11%	4,54E-02	0%			2,59E-01	2%
	Façade openings (including windows and external doors)	4,32E-01	4%	3,46E-03	0%	4,44E-01	4%	1,28E-02	0%
Roof	External paints, coatings and renders	1,11E-01	1%	2,74E-03	0%	4,79E-01	5%	2,33E-03	0%
	Structure	1,76E-01	2%	3,57E-02	0%			3,93E-02	0%
	Weatherproofing	2,31E-01	2%	1,13E-02	0%	5,63E-01	5%	3,41E-01	3%
Parking facilities	Above ground and underground (within the curtilage of the building and servicing the building occupiers)								
Fittings and furnishings	Sanitary fittings	1,19E-03	0%	1,84E-05	0%	1,28E-03	0%	7,54E-05	0%
	Cupboards, wardrobes and worktops (where provided in residential property)								
	Ceilings								
	Wall and ceiling finishes	9,70E-01	9%	2,38E-02	0%	6,44E-01	6%	1,42E-02	0%
In built lighting system	Floor coverings and finishes	3,11E-01	3%	1,70E-01	2%			6,26E-02	1%
	Light fittings								
Energy system	Control systems and sensors								
	Heating plant and distribution								
	Cooling plant and distribution								
Ventilation system	Electricity generation and distribution								
	Air handling units								
Sanitary systems	Ductwork and distribution								
	Cold water distribution								
	Hot water distribution								
	Water treatment systems								
Other systems	Drainage system								
	Lifts and escalators	4,55E-02	0%	3,61E-04	0%	4,79E-02	0%	2,02E-03	0%
	Firefighting installations								
Utilities	Communication and security installations								
	Telecoms and data installations								
Landscaping	Connections and diversions								
	Substations and equipment								
	Paving and other hard surfacing								
	Fencing, railings and walls								
	Drainage systems								

Environmental Hotspots Materials

Global Warming Potential (GWP)

Method: IPCC 2013 GWP 100a V1.03 based on EN 15804

Unit: varies

Life Cycle Stages - Sum of whole Life Cycle per m² and year

Material	Global Warming Potential		Depletion potential of the stratospheric ozone layer (ODP)		Acidification Potential of land and water (AP)		Eutrophication Potential (EP)		Formation potential of tropospheric ozone photochemical oxidants (POCP)		ADP elements		ADP fossil fuels	
	[kg CO2 eq]	[%]	[kg CFC11 eq]	[%]	[kg SO2 eq]	[%]	[kg (PO4)3 eq]	[%]	[kg C2H4 eq]	[%]	[kg Sb eq / m ²]	[%]	[MJ (LHV)]	[%]
Sum	1,05E+01	100,00%	8,34E-07	100,00%	3,12E-02	100,00%	4,50E-03	100,00%	1,99E-03	100,00%	4,96E-05	100,00%	9,19E+01	100,00%
ConcreteFoundation	8,39E-01	8,02%	6,26E-08	7,51%	2,05E-03	6,57%	3,52E-04	7,82%	1,03E-04	5,19%	9,47E-07	1,91%	5,20E+00	5,66%
ConcreteInSitu	1,29E+00	12,31%	1,19E-07	14,28%	3,55E-03	11,40%	6,14E-04	13,64%	1,67E-04	8,43%	1,80E-06	3,62%	9,74E+00	10,60%
ReinforcingSteel	3,34E-01	3,19%	4,62E-08	5,54%	1,64E-03	5,26%	2,44E-04	5,43%	1,07E-04	5,41%	8,40E-07	1,69%	4,61E+00	5,02%
XPS	1,38E+00	13,19%	1,50E-08	1,80%	1,91E-03	6,12%	1,94E-04	4,30%	2,11E-04	10,65%	3,76E-07	0,76%	1,18E+01	12,87%
LimePlaster	2,25E+00	21,48%	1,26E-07	15,08%	4,92E-03	15,78%	6,37E-04	14,16%	2,29E-04	11,52%	8,89E-07	1,79%	1,32E+01	14,40%
Brick	2,29E+00	21,91%	2,55E-07	30,55%	6,27E-03	20,12%	9,06E-04	20,15%	4,21E-04	21,22%	4,84E-06	9,75%	2,37E+01	25,77%
CementMortar	3,37E-01	3,22%	2,18E-08	2,62%	9,40E-04	3,01%	1,31E-04	2,91%	4,89E-05	2,46%	2,71E-07	0,55%	2,03E+00	2,21%
ConcretePrefab	2,67E-02	0,26%	2,65E-09	0,32%	8,22E-05	0,26%	1,37E-05	0,31%	4,23E-06	0,21%	4,17E-08	0,08%	2,27E-01	0,25%
SawnTimber	1,79E-02	0,17%	3,45E-09	0,41%	1,21E-04	0,39%	2,88E-05	0,64%	3,10E-05	1,56%	4,59E-08	0,09%	2,39E-01	0,26%
AnhydriteFloor	1,94E-01	1,85%	3,02E-08	3,63%	1,09E-03	3,50%	1,41E-04	3,14%	5,39E-05	2,72%	4,39E-07	0,88%	2,81E+00	3,05%
PVCfoil	3,54E-02	0,34%	2,01E-09	0,24%	5,67E-05	0,18%	7,18E-06	0,16%	3,28E-06	0,17%	1,73E-08	0,03%	3,51E-01	0,38%
Rockwool	8,15E-03	0,08%	6,18E-10	0,07%	6,39E-05	0,21%	5,43E-06	0,12%	3,99E-06	0,20%	1,77E-08	0,04%	9,76E-02	0,11%
Double flooring system	8,10E-03	0,08%	6,34E-10	0,08%	2,87E-05	0,09%	3,60E-06	0,08%	2,07E-06	0,10%	1,47E-08	0,03%	1,18E-01	0,13%
Plywood	3,42E-01	3,27%	5,81E-08	6,97%	1,80E-03	5,76%	2,97E-04	6,60%	1,99E-04	10,04%	1,51E-06	3,04%	5,20E+00	5,66%
EPDM	5,67E-02	0,54%	8,17E-10	0,10%	9,16E-05	0,29%	7,94E-06	0,18%	5,23E-06	0,26%	1,03E-08	0,02%	9,87E-01	1,07%
Gravel	1,98E-02	0,19%	4,51E-09	0,54%	8,40E-05	0,27%	1,53E-05	0,34%	3,68E-06	0,19%	9,78E-08	0,20%	3,05E-01	0,33%
GlazingTriple	6,11E-01	5,84%	5,10E-08	6,12%	3,93E-03	12,59%	3,96E-04	8,80%	2,18E-04	10,96%	9,11E-06	18,35%	6,63E+00	7,22%
FrameWood	2,60E-01	2,48%	1,96E-08	2,36%	1,47E-03	4,72%	1,78E-04	3,95%	1,07E-04	5,40%	8,33E-06	16,79%	2,79E+00	3,03%
GlazingDouble	6,51E-02	0,62%	7,77E-09	0,93%	4,74E-04	1,52%	4,12E-05	0,92%	1,95E-05	0,98%	2,25E-07	0,45%	7,08E-01	0,77%
SanitaryCeramics	2,56E-03	0,02%	3,83E-10	0,05%	7,55E-06	0,02%	1,06E-06	0,02%	5,01E-07	0,03%	1,29E-08	0,03%	3,53E-02	0,04%
Aluminium	1,50E-03	0,01%	6,66E-11	0,01%	8,06E-06	0,03%	7,16E-07	0,02%	4,98E-07	0,03%	7,39E-08	0,15%	1,40E-02	0,02%
Cast Iron	2,66E-02	0,25%	1,62E-09	0,19%	1,10E-04	0,35%	1,18E-05	0,26%	1,61E-05	0,81%	1,90E-08	0,04%	2,87E-01	0,31%
Copper	6,72E-04	0,01%	6,20E-11	0,01%	2,26E-05	0,07%	1,72E-05	0,38%	8,18E-07	0,04%	5,99E-07	1,21%	7,53E-03	0,01%
Steel	1,06E-02	0,10%	1,21E-09	0,14%	5,02E-05	0,16%	6,52E-06	0,14%	3,72E-06	0,19%	6,44E-08	0,13%	1,40E-01	0,15%
Polyethylene	2,34E-03	0,02%	5,25E-12	0,00%	1,93E-06	0,01%	1,72E-07	0,00%	1,04E-07	0,01%	9,75E-11	0,00%	2,15E-02	0,02%
Electronics	5,48E-02	0,52%	3,87E-09	0,46%	4,07E-04	1,30%	2,48E-04	5,51%	2,48E-05	1,25%	1,90E-05	38,37%	6,03E-01	0,66%

Environmental Hotspots

Global Warming Potential (GWP)

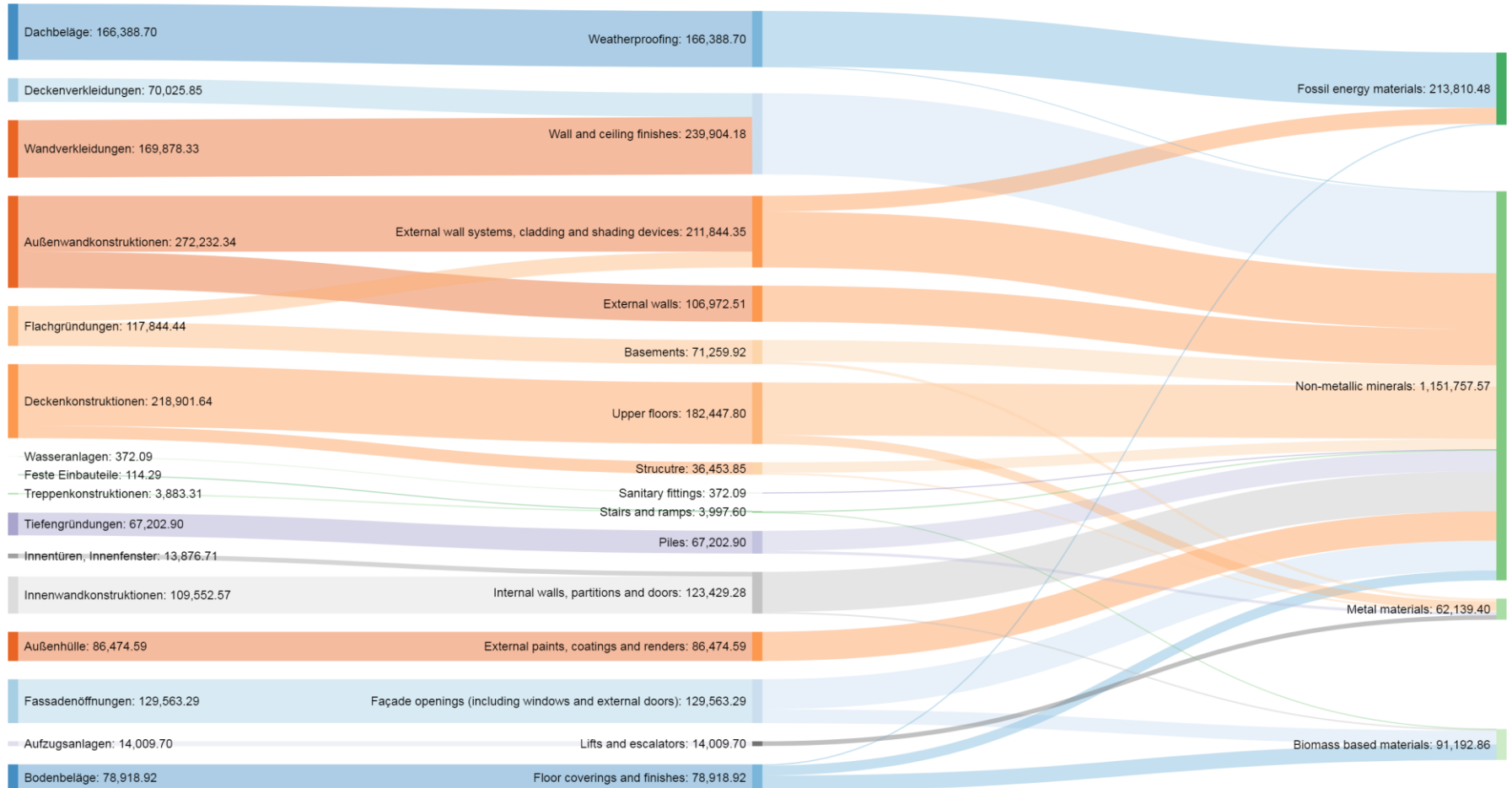
Method: IPCC 2013 GWP 100a V1.03

Unit: kg CO₂ eq

ÖNORM B1801
Elemente

Level(s)
Elemente

Eurostat
Materiale



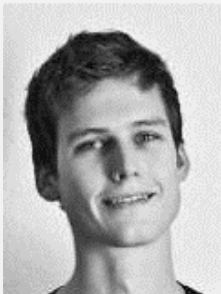
- **Benefits**
 - Alignment of macro-objectives and specific building-related requirements
 - Valuable information for circularity and BAMB from assignment of Eurostat material categories
 - Benefits from tools provided for default values, e.g. water use

- **Recommendations (on LCA-related aspects)**
 - Distinction of embodied and operational impacts (separate reporting of B6,B7 and use-related embodied impacts (e.g. B4))
 - Impacts by contribution from building parts (as BoQ reporting)
 - Enable reporting of full list of LCA indicators (EN 15804:A2)



Alexander Passer

Assoc.Prof. Dipl.-Ing. Dr.techn. MSc
 Arbeitsgruppe Nachhaltiges Bauen
 Waagner-Biro-Straße 100/XI
 8020 Graz
 +43 (316) 873 - 7153
 alexander.passer@tugraz.at



Martin Röck

Dipl.-Ing. BSc
 Arbeitsgruppe Nachhaltiges Bauen
 Waagner-Biro-Straße 100/XI
 8020 Graz
 +43 (316) 873 - 7652
 martin.roeck@tugraz.at