

A. Additional Information on “Mixed-unit hybrid life cycle assessment applied to the recycling of construction materials”

2.1 Important processes in the upstream cut-off matrix

The red columns in Figure 5 are constructed by allocating selected IO technology coefficient sector data to selected AusLCI processes in the C^u matrix:

- “Electricity generation” industry sector column from use table of the IO system for the “Fly ash, delivered to plant/AU U” process
- “BOF steel manufacturing” industry sector column from use table of the IO system for the “Ground granulated blast furnace slag, at cement plant/AU U” process
- “Other basic chemical manufacturing” industry sector column from use table of the IO system for the “Sodium hydroxide, 50% in H₂O, membrane cell, at plant/RER U/AusSD U” and the “Sodium silicate, furnace liquor, 37% in H₂O, at plant/RER U/AusSD U” processes
- “Waste from manufacture of iron and steel” industry sector column from use table of IO system for the “Iron scrap, at plant/RER U/AusSD U” process

2.2 Numerical results of figures

All the figures presented in the “results and discussion” section are summarised numerically in the tables below.

Table S1: Contributions of main GHGEs for FA-based geopolymers concrete production by MU-hLCA, IO-hLCA and LCA methodologies (Figure 6)

	MU-hLCA (this study) (kg CO ₂ -eq/ m ³)	IO-hLCA (Teh et al, 2017) (kg CO ₂ -eq/ m ³)	LCA (Turner et al. 2013) (kg CO ₂ -eq/ m ³)	LCA (Davidovits, 2015) based on (Turner et al. 2013) (kg CO ₂ -eq/ m ³)
Cement	0	0	0	0
Concrete	33	33	0	0
Electricity	27	27	40	0
Gravel	15	15	49	49

Sand	5	5	9	9
Road Transport	16	16	9	9
Admixtures	0	0	1	1
FA (Fly Ash)	26	109	11	11
GGBFS (Slag)	19	7	0	0
Others	44	44	12	12
NaOH	61	32	34	34
Na₂SiO₃	119	57	156	45
Total	364	345	321	170

Table S2: Contributions of upstream and downstream cut-off matrix for FA-based geopolymer concrete production using MU-hLCA (Figure 7)

	Data in C^u and C^d (kg CO ₂ -eq/ m ³)	Data in C^d only (kg CO ₂ -eq/ m ³)	No data in C^u and C^d (kg CO ₂ -eq/ m ³)
Cement	0	0	0
Concrete	33	33	33
Electricity	27	27	27
Gravel	15	15	15
Sand	5	5	5
Road Transport	16	16	16
Admixtures	0	0	0
FA (Fly Ash)	26	7	0
GGBFS (Slag)	19	9	0
Others	44	44	44
NaOH	61	50	0
Na₂SiO₃	119	81	0
Total	364	287	140

Table S1: CFIs of geopolymer and OPC concrete, with either natural aggregate or 100% recycled concrete aggregate (Figure 8)

	NA OPC Concrete (kg CO ₂ -eq/ m ³)	RCA OPC Concrete (kg CO ₂ -eq/ m ³)	NA GPC (kg CO ₂ -eq/ m ³)	RCA GPC (kg CO ₂ -eq/ m ³)
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Cement	413	413	0	0
Concrete	33	33	33	33
Electricity	18	18	27	27
NA (Gravel)	9	0	15	0
RCA	0	7	0	11
Sand	3	3	5	5
Road Transport	11	11	16	16
Admixtures	1	1	0	0
FA (Fly Ash)	0	0	26	26
GGBFS (Slag)	0	0	19	19
NaOH	0	0	61	61
Na₂SiO₃	0	0	119	119
Others	30	30	44	44
Total	519	516	364	361

Table S2: CFIs of BOF and EAF steel, with the use of iron and steel scrap (Figure 9)

	BOF Steel (kg CO ₂ -eq/ kg)	EAF Steel (kg CO ₂ -eq/ kg)
Iron and Steel Manufacturing	0.968	0.079
Iron ore	0.004	0.041
Electricity generation	0.049	0.301
Road transport	0.036	0.029
Coal mining	0.036	0.003
Oil and gas extraction	0.033	0.033
Iron and steel bars, rods, angles, shapes and sections	0.034	0.024
Iron and steel scrap	0.028	0.127
Others	0.323	0.228
Total	1.511	0.87