Carbon Footprint of a Typical Neapolitan Pizzeria

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Supplementary Materials

Table S1. Emission factors for the energy sources, means of transport, production of raw and packaging materials, and disposal of processing and post-consumer wastes used to assess the cradle-to-grave carbon footprint of a Neapolitan pizzeria, as extracted from Ecoinvent v. 3.7 database of the LCA software Simapro (Prè Consultants, Amersfoort, NL) and other papers.

Emission Factor	Value	Unit	Ref.
Energy source			
Electricity, low voltage (<1kV), grid/IT	0.452	kg CO_{2e} kWh^{-1}	Ecoinvent v. 3.7
Electricity production, wind, >3MW turbine onshore{IT}| Cut-off, S	0.0293	kg CO_{2e} kWh^{-1}	Ecoinvent v. 3.7
Electricity production, hydro, reservoir, alpine region{IT}| Cut-off, S	0.00594	kg CO_{2e} kWh^{-1}	Ecoinvent v. 3.7
Woodfire	0.0406	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7+ SimaPro 9.2
Means of transport			
Transport, lorry 3.5-7.5Mg, Euro5	0.506	kg CO_{2e} Mg^{-1} km^{-1}	Ecoinvent v. 3.7
Transport, lorry 7.5-16 Mg, Euro5	0.212	kg CO_{2e} Mg^{-1} km^{-1}	Ecoinvent v. 3.7
Transport, freight, light commercial vehicle {EU without CH}| Cut-off, S	1.83	kg CO_{2e} Mg^{-1} km^{-1}	Ecoinvent v. 3.7
Municipal waste collection service by 21-Mg ton lorry {RoW}| Cut-off, S	1.27	kg CO_{2e} Mg^{-1} km^{-1}	Ecoinvent v. 3.7
Raw Materials			
Tap Water {EU without CH}| Cut-off, U	0.278	kg CO_{2e} m^{-3}	Ecoinvent v. 3.7
Soft wheat flour	0.61±0.23	kg CO_{2e} kg^{-1}	SUEATABLE_LIFE database [35]
Compressed yeast	0.82	kg CO_{2e} kg^{-1}	SUEATABLE_LIFE database [35]
Peeled tomatoes	1.28±0.4	kg CO_{2e} kg^{-1}	SUEATABLE_LIFE database [35]
Fresh tomatoes	0.48±0.30	kg CO_{2e} kg^{-1}	SUEATABLE_LIFE database [35]
Water Buffalo Mozzarella cheese	32.7±0.1	kg CO_{2e} kg^{-1}	Berlese et al. (2019) [53]
Mozzarella cheese	8.5±1.4	kg CO_{2e} kg^{-1}	SUEATABLE_LIFE database [35]
Grana Padano cheese	14.3±2.8	kg CO_{2e} kg^{-1}	SUEATABLE_LIFE database [35]
Ricotta cheese	3.4	kg CO_{2e} kg^{-1}	SUEATABLE_LIFE database [35]

Provola cheese	10.82	kg CO_{2e} kg^{-1}	SUEATABLE_LIFE database [35]
Pecorino Romano cheese	18.9±2.4	kg CO_{2e} kg^{-1}	SUEATABLE_LIFE database [35]
Naples salami	11.3	kg CO_{2e} kg^{-1}	[38]
Baked ham	10.7	kg CO_{2e} kg^{-1}	[38]
Deboned pressed dry-cured ham	12.7±4.0	kg CO_{2e} kg^{-1}	[38]
Cracklings	0.82	kg CO_{2e} kg^{-1}	Animal meal, from dry rendering, at plant/NL Economic: Agri-footprint Economic Allocation
Baby artichokes	0.41±0.11	kg CO_{2e} kg^{-1}	[36, 35]
Mushrooms	1.8±1.1	kg CO_{2e} kg^{-1}	SUEATABLE_LIFE database [35]
Rucola leaves	0.40±0.15	kg CO_{2e} kg^{-1}	SUEATABLE_LIFE database [35]
Escarole	0.40±0.15	kg CO_{2e} kg^{-1}	SUEATABLE_LIFE database [35]
Eggplant	1.35±0.07	kg CO_{2e} kg^{-1}	[35, 36]
Peppers	1.18±0.08	kg CO_{2e} kg^{-1}	SUEATABLE_LIFE database [35]
Broccoli	0.67±0.36	kg CO_{2e} kg^{-1}	SUEATABLE_LIFE database [35]
Table salt	0.159	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7
Extra-virgin olive oil	3.8±2.8	kg CO_{2e} kg^{-1}	SUEATABLE_LIFE database [35]
Oregano	1.6	kg CO_{2e} kg^{-1}	[39]
Garlic	0.67±0.07	kg CO_{2e} kg^{-1}	SUEATABLE_LIFE database [35]
Extra-virgin olive oil	3.8±2.8	kg CO_{2e} kg^{-1}	SUEATABLE_LIFE database [35]
Basil leaves	1.6	kg CO_{2e} kg^{-1}	[40]
Beverages			
Mineral water in 75-cL glass bottles	0.63±0.02	kg CO_{2e} L^{-1}	[41-42]
Beer in 75-cL glass bottles	0.69±0.52	kg CO_{2e} L^{-1}	[35, 55]
Beer in 33-cL glass bottles	0.79±0.52	kg CO_{2e} L^{-1}	[35, 55]
Coca-Cola in 33-cL glass bottles	1.09	kg CO_{2e} L^{-1}	[43]
Coca-Cola Zero in 33-cL aluminum cans	0.45	kg CO_{2e} L^{-1}	[43]
Fanta in 33-cL aluminum cans	0.52	kg CO_{2e} L^{-1}	[43]
Packaging Materials			
EPA wooden pallet	0.244	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7+ SimaPro 9.2
25-kg paper bags	1.51	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7+ SimaPro 9.2
25-g multilayer foil	3.21	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7+ SimaPro 9.2
400-g metal can	2.47	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7+ SimaPro 9.2

5.0-kg wooden box	1.5	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7+ SimaPro 9.2
3.0-kg polystirene box	4.13	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7+ SimaPro 9.2
PE bag of different capacities	2.53	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7+ SimaPro 9.2
1.5-kg paper layer	0.557	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7+ SimaPro 9.2
0.6-kg twine net	12.4	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7+ SimaPro 9.2
1-kg glass jar	1.07	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7+ SimaPro 9.2
1 metal lid	2.82	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7+ SimaPro 9.2
100-g bunches using plasticized wire	2.2	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7+ SimaPro 9.2
0.6-kg wooden cassette	1.5	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7+ SimaPro 9.2
15-kg PP box	3.14	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7+ SimaPro 9.2
1-kg light cardboard box	1.40	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7+ SimaPro 9.2
5-L metal can	4.28	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7+ SimaPro 9.2
1-kg PET jar	3.80	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7+ SimaPro 9.2
100-g PE net	2.84	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7+ SimaPro 9.2
300-g PE tray	2.84	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7+ SimaPro 9.2
Al-PET coated cardboard pizza box	1.41	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7+ SimaPro 9.2
PET tanks or bottles of different volumes	1.94	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7+ SimaPro 9.2
Detergents			
Dishwashing liquid detergent	0.62	kg CO_{2e} kg^{-1}	[26]; Ecoinvent v. 3.7+ SimaPro 9.2
Floor washing liquid detergent	0.66	kg CO_{2e} kg^{-1}	[26]; Ecoinvent v. 3.7+ SimaPro 9.2
Glass window cleaner detergent	0.64	kg CO_{2e} kg^{-1}	[26]; Ecoinvent v. 3.7+ SimaPro 9.2
Toilet detergent	2.56	kg CO_{2e} kg^{-1}	[26]; Ecoinvent v. 3.7+ SimaPro 9.2
Table set			
Ceramic plates	1.83	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7+ SimaPro 9.2
Stainless steel cutlery	7.91	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7+ SimaPro 9.2
Glasses	1.07	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7+ SimaPro 9.2
Paper tablecloths	1.59	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7+ SimaPro 9.2
Paper napkins	1.59	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7+ SimaPro 9.2
Wastewater treatment and waste disposal			
Wastewater treatment, av. {EU without CH}| capacity 1E9 l/yr	Cut-off, S	0.476	kg CO_{2e} m^{-3}	Ecoinvent v. 3.7
Landfill			
Waste Paperboard {RoW} treatment of sanitary landfill| Cut-off, S	1.52	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7

Waste plastic, mixture {RoW}| treatment of sanitary landfill| Cut-off, S	0.102	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7
Waste aluminum {RoW}, treatment of sanitary landfill| Cut-off, S	0.0383	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7
Waste wood, untreated {RoW}| treatment of sanitary landfill| Cut-off, S	0.0747	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7
Sludge from pulp&paper production{RoW}|treatment of, sanitary landfill| Cut-off, S assumed as equivalent to landfilling of organic waste	1.14	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7
Glass waste {CH}| treatment of inert material landfill Cut-off, S	0.00418	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7
Scrap steel {EU without CH}| inert material landfill| Cut-off, S	0.00516	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7
Wood ash mixture, pure {RoW}| treatment of, sanitary landfill	Cut-off, S	0.0184	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7
Municipal solid waste {RoW}| treatment of, sanitary landfill	Cut-off, S	0.626	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7
Recycling			
Paper (waste treatment) {GLO}| recycling of paper	Cut-off, S	0	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7
Paper (waste treatment) {GLO}| recycling of paper	APOS, S	-0.139	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7
Mixed plastics (waste treatment) {GLO}| recycling of mixed plastics	Cut-off, S	0	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7
Mixed plastics (waste treatment) {GLO}| recycling of mixed plastics	APOS, S	-1.73	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7
Aluminum (waste treatment) {GLO}| recycling of aluminium	Cut-off, S	0	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7
Aluminum (waste treatment) {GLO}| recycling of aluminium	APOS, S	-21.8	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7
Packaging glass, white {GLO}| recycling of packaging glass| Cut-off, S	0	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7
Packaging glass, white {GLO}| recycling of packaging glass| APOS, S	-1.26	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7
Steel and iron (waste treatment) {GLO}| recycling of steel and iron	Cut-off, S	0	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7
Steel and iron (waste treatment) {GLO}| recycling of steel and iron	APOS, S	-1.73	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7
Waste wood, untreated {IT}| market for waste wood, untreated	Cut-off, S	0.0585	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7
Waste wood, untreated {IT}| market for waste wood, untreated	APOS, S	0.0776	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7
Biowaste {RoW}| treatment of biowaste, industrial composting	Cut-off, S	0.0588	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7
Biowaste {RoW}| treatment of biowaste, industrial composting	APOS, S	0.0589	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7
Biowaste {RoW}| treatment of biowaste by anaerobic digestion	Cut-off, S	0.118	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7
Biowaste {RoW}| treatment of biowaste by anaerobic digestion	APOS, S	0.148	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7
Incineration			

Waste paperboard {RoW}| treatment of, municipal incineration | Cut-off, S	0.0316	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7
Waste plastic, mixture {RoW}| treatment of, municipal incineration | Cut-off, S	2.38	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7
Waste wood, untreated {RoW}| treatment of, municipal incineration | Cut-off, S	0.0145	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7
Scrap aluminum {RoW}| treatment of, municipal incineration | Cut-off, S	0.0135	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7
Raw sewage sludge {RoW}| treatment of, municipal incineration | Cut-off, S	0.0772	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7
Scrap steel {EU without CH}| treatment of, municipal incineration | Cut-off, S	0.0102	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7
Waste glass {RoW}| treatment of, municipal incineration | Cut-off, S	0.0175	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7
Municipal solid waste {IT}| treatment of, incineration | Cut-off, S	0.519	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7
Municipal solid waste {IT}| treatment of, incineration | APOS, S	0.520	kg CO_{2e} kg^{-1}	Ecoinvent v. 3.7

Table S2. Details of the LCA model used to estimate the carbon footprint of the 168-g cardboard pizza box using the software SimaPro and embedded databases.

| Documentation | **Input/output** | Parameters | System description |

Products

Outputs to technosphere: Products and co-products	Amount	Unit	Quantity	Allocatic	Waste type	Category	Comment
Pizza- Cardboard box	168	g	Mass	100 %	Cardboard	...\Transformation	
Add							

Outputs to technosphere: Avoided products	Amount	Unit	Distributior	SD2 or 2SE	Min	Max	Comment
Add							

Inputs

Inputs from nature	Sub-compartment	Amount	Unit	Distributior	SD2 or 2SE	Min	Max	Comment
Add								

Inputs from technosphere: materials/fuels	Amount	Unit	Distribi	SD2 o	Min	Max	Comment
Aluminium, primary, ingot {IAI Area, EU27 & EFTA}| production	Cut-off, S	11.11	g	Undefi			
Corrugated board box {RER}| production	Cut-off, S	168-11.11-5.12 = 152	g				
Polyethylene terephthalate, granulate, amorphous, recycled {RoW}	polyethylene terephthalate productic	5.12	g	Undefi			
Add							

Inputs from technosphere: electricity/heat	Amount	Unit	Dis	SD2 oı	Min	Max	Comment
Sheet rolling, aluminium {RER}| processing	Cut-off, S	11.11	g	Un			
Laminating service, foil, with acrylic binder {RER}| processing	Cut-off, S	2925	cm2	Un			
Transport, freight, lorry 7.5-16 metric ton, EURO5 {RER}| transport, freight, lorry 7.5-16 metric ton, EURO5	Cut-off, S	0/1000*300 = 0	kgkm				PS - FG
Extrusion, plastic film {RER}| extrusion, plastic film	Cut-off, S	5.12	g	Un			

Table S3. Details of the LCA model used to estimate the carbon footprint of the 5-L metal can containing extra-virgin olive oil using the software SimaPro and embedded databases.

| Documentation | **Input/output** | Parameters | System description |

Products

Outputs to technosphere: Products and co-products	Amount	Unit	Quantity	Allocatic	Waste type	Category	Comment
Pizza- EVOO 5-kg can	1	kg	Mass	100 %	Steel	...\Transformation	
Add							

Outputs to technosphere: Avoided products	Amount	Unit	Distributior	SD2 or 2SE	Min	Max	Comment
Add							

Inputs

Inputs from nature	Sub-compartment	Amount	Unit	Distributior	SD2 or 2SE	Min	Max	Comment
Add								

Inputs from technosphere: materials/fuels	Amount	Unit	Distribi	SD2 o	Min	Max	Comment
Steel, low-alloyed {RoW}| steel production, converter, low-alloyed	Cut-off, S	1	kg	Undefi			
Add							

Inputs from technosphere: electricity/heat	Amount	Unit	Dis	SD2 oı	Min	Max	Comment
Transport, freight, lorry 7.5-16 metric ton, EURO5 {RER}| transport, freight, lorry 7.5-16 metric ton, EURO5	Cut-off, S	0/1000*300 = 0	kgkm				PS - FG
Metal working, average for steel product manufacturing {RoW}| processing	Cut-off, S	1	kg	Un			
Add							

Table S4. Mass of several Marinara and Margherita pizza types as weighted at the inlet and outlet of the wood-fired oven, or just 2 minutes later when put in a plate or cardboard to be served.

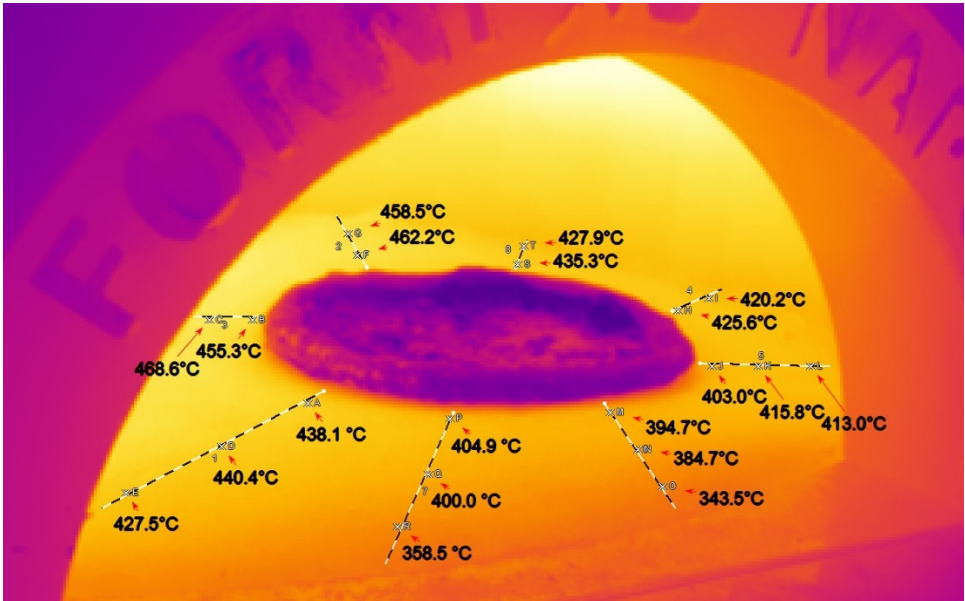| Pizza Mass	Marinara Pizza	Margherita Pizza	Unit
As entering the wood-fired oven	350±4	417±6	g
As exiting from the wood-fired oven	313±2	377±5	g
As dished to be served	311±2	375±5	g

Figure S1. Radial profiles of the temperature of the wood-fired oven floor, as measured using a non-contact infrared thermometer.

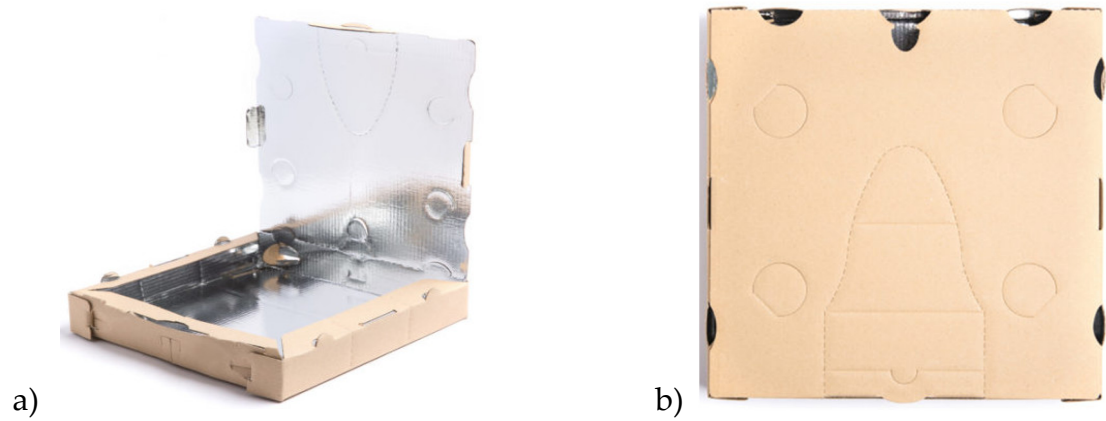a)   b)

Figure S2. Pictures of the empty open (**a**) and closed (**b**) pizza corrugated cardboard boxes used in the pizzeria examined in this work.