## Environmental Product Declaration (EPD)

Based on ISO 14040, ISO 14044, and ISO 14025 frameworks

## Product Identification Product name: Ceramic Mug vs. Paper Cup Functional unit: One beverage consumed (per drink) System boundary: Cradle-to-gate + use phase (washing for mug) Geographical scope: Europe (generic energy mix) Software & method: openLCA 2.x, IPCC 2013 GWP 100a Database: Custom (ELCD 3.2-based flows)

## Goal and Scope

This study compares the global warming potential (GWP) of a reusable ceramic mug and a single-use paper cup. The objective is to demonstrate LCA modeling, parameterization, and interpretation skills using openLCA.   
End-of-life impacts are excluded; results represent cradle-to-gate + use phase.

## System Boundaries

|  |  |  |
| --- | --- | --- |
| **Life-Cycle Stage** | **Included** | **Description** |
| **Raw material extraction** | Yes | Clay and paperboard production |
| **Manufacturing** | Yes | Cup forming and ceramic firing |
| **Distribution** | No | Excluded (assumed negligible) |
| **Use phase** | Yes | Washing (ceramic mug only) |
| **End-of-life** | No | Excluded from baseline scenario |

## Key Assumptions and Parameters

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | **Value** | **Unit** | **Description** |
| **Mug mass** | 0.35 | kg | Typical ceramic mug |
| **Mug lifetime** | 500 | uses | Reuse cycles assumed |
| **Washing electricity** | 0.02 | kWh/use | Dishwashing energy |
| **Washing water** | 0.5 | L/use | Tap water consumption |
| **Paper cup mass** | 0.01 | kg | Average 250 mL paper cup |
| **EF ceramic production** | 1.0 | kg CO₂/kg | Emission factor |
| **EF paper cup** | 1.05 | kg CO₂/kg | Average primary data |
| **EF electricity** | 0.421 | kg CO₂/kWh | EU grid average |
| **EF water** | 0.0003 | kg CO₂/L | Water supply & treatment |

## Life Cycle Impact Assessment (LCIA) Results

Impact category: Global Warming Potential (GWP 100a, kg CO₂-eq)

|  |  |  |  |
| --- | --- | --- | --- |
| **Scenario** | **Production** | **Use phase** | **Total (per drink)** |
| **Paper cup** | 0.0105 | — | 0.0105 |
| **Ceramic mug** | 0.35 / 500 = 0.0007 | 0.0202 | 0.0209 |

Result: The mug emits ~ 0.0209 kg CO₂ per drink, versus 0.0105 kg CO₂ for a paper cup.   
Under baseline assumptions, washing dominates the mug’s footprint; no carbon break-even occurs within 500 uses.

## Interpretation

The ceramic mug’s impact is driven by washing energy. Increasing lifetime or reducing washing electricity could achieve a positive break-even.   
The paper cup has a lower per-drink footprint but accumulates over frequent use.

## Limitations

Transportation and end-of-life impacts were excluded. Data are generic; results are indicative only.   
This EPD follows ISO 14040 principles for educational demonstration and is not valid for commercial verification.