

Life Cycle Assessment Report of A pair of US6 Women's Sport Sandals

1. Goal and Scope Definition

1.1. Goal Definition

1.1.1. Product Information

The subject of this study is a pair of US6 women's sport sandals, with the following specifications:

- **Model:** US6
- **Shape and Form:** Sport Sandals



1.1.2. Functional Unit and Reference Flow

This report defines the functional unit as the production of a pair of US6 women's sport sandals. The reference flow is one pair.

1.1.3. Data Representativeness

The representativeness of the data in terms of time, geography, and technology is as follows:

- **Time Representativeness:** 2023
- **Geographical Representativeness:** China

1.2. Scope Definition

1.2.1. System Boundary

This study defines the system boundary from raw material acquisition to the finished product.





Figure 2 System Boundary Diagram

1.2.2. Cut-off Criteria

The cut-off criteria adopted in this study are based on the weight proportion of material inputs relative to the total weight of the product or process. The specific rules are as follows:

- Ordinary materials weighing less than 1% of the total product weight, and materials containing rare or high-purity components weighing less than 0.1% of the total product weight, may be excluded. The total excluded material weight does not exceed 5%.
- Low-value waste used as raw material, such as fly ash, slag, straw, and municipal waste, may be excluded from upstream production data.

- In most cases, production equipment, plant facilities, and living facilities may be excluded.
- Known emission data within the selected environmental impact categories should not be omitted.

1.2.3. Environmental Impact Categories

Impact Category	Unit	Key Inventory Substances
Climate Change	kg CO ₂ eq.	CO ₂ , CH ₄ , N ₂ O...
Primary Energy Consumption	MJ	Hard coal, lignite, natural gas...
Non-renewable Resource Consumption	kg Sb eq.	Iron, manganese, copper...
Water Resource Consumption	kg	Freshwater, surface water, groundwater...
Acidification	kg SO ₂ eq.	SO ₂ , NO _x , NH ₃ ...
Eutrophication	kg PO ₄ ³⁻ eq.	NH ₃ , NH ₄ -N, COD...
Inhalable Inorganic Particles	kg PM2.5 eq.	CO, PM10, PM2.5...
Ozone Layer Depletion	kg CFC-11 eq.	CCl ₄ , C ₂ H ₃ Cl ₃ , CH ₃ Br...
Photochemical Ozone Formation	kg NMVOC eq.	C ₂ H ₆ , C ₂ H ₄ ...

Note: eq is the abbreviation of equivalent. For example, the climate change index is based on CO₂ as the reference substance.

Other greenhouse gases have their own CO₂ equivalent factors according to the strength of the greenhouse effect. Therefore, the greenhouse gas emissions of various products in the life cycle can be multiplied by the equivalent factors, and the total climate change index (usually also called product carbon footprint, PCF) is accumulated. The unit is kg CO₂ eq.

(The environmental impact type indicators supported by the system are displayed, and the indicators can be deleted as needed)

1.2.4. Data Quality Requirements

Data quality assessment in this report follows the CLCD methodology, which evaluates consumption and emission inventory data based on:

1. Data source and calculation methodology
2. Time representativeness
3. Geographical representativeness
4. Technological representativeness

The background database's consumption data is evaluated for uncertainty concerning its upstream background process match. Uncertainty propagation and accumulation are then computed using analytical formula methods.

1.2.5. Software and Database

This study uses the eFootprint software system to build the life cycle model for a pair of US6 women's sandals and calculate LCA results. eFootprint is an online LCA analysis tool developed by IKE Environmental Technology Co., Ltd., supporting full life cycle process analysis.

The background data sources used in the life cycle process are summarized in the following table:

Inventory Name	Model	Process	Dataset Name	Remark
Electricity	US6 Women's Sport Sandals [Production]	East China Grid Power	CLCD-China 0.9	
Glue	US6 Women's Sport	Synthetic	External	

	Sandals [Production]	Adhesive	Database	
TPR Granules	TPR Sole Production [Production]	Rubber Products	External Database	
EVA	EVA Midsole [Production]	EVA	CLCD- China 0.9	
Textile Upper	Textile Upper [Production]	Fabric	External Database	
TPR Sole	US6 Women's Sport Sandals [Production]	TPR Sole Production	External Database	
EVA Foam	EVA Midsole [Production]	Foam Production	CLCD- China 0.9	
Water Consumption	US6 Women's Sport Sandals [Production]	Water Resource Use	CLCD- China 0.9	
Transportation	US6 Women's sport Sandals [Production]	Logistics	CLCD- China 0.9	

2. Data Collection

2.1. US6 Women's Sandals [Production]

(1) Process Information

- **Process Name:** US6 Women's Sport Sandals [Production]
- **Process Boundary:** Raw materials to finished sandals

(2) Data Representativeness

- **Primary Data Source:** Representative enterprise and supply chain actual data
- **Enterprise Name:** Fuqing Fushengda Plastic Products Co., Ltd.
- **Location:** China
- **Baseline Year:** 2023

Table. The Process Inventory Data

Type	Inventory Name	Quantity	Unit	Upstream Data Source	Usage/Emission Reason
Product Output	US6 Women's Sport Sandals	1	Item (s)	Actual process data	--
Raw Material	TPR Sole Production	1	Item (s)	Actual process data	--
Raw Material	EVA Midsole	1	Item (s)	Actual process data	--
Raw Material	Textile Upper	1	Item (s)	Actual process data	--
Raw Material	Glue	0.00015	kg	huangshuying0212@163.com (1.0)	--
Energy	Electricity	0.0015	kWh	CLCD-China (0.9)	--
Environmental Emission	Carbon Dioxide [Emitted to Air (Unspecified)]	2	kg	--	--
Environmental Emission	4,4'-Methylenedianiline [Emitted to	0.007896	kg	--	--

	Air (Urban Area)]				
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(3) Transportation Information

Material	Gross Weight	Origin	Destination	Transport Distance	Transport Type
Glue	1.65E-04 kg	Nanbin Glue Factory	Fushengda Factory	1 km	Truck (10t) - Gasoline

3. Life Cycle Impact Analysis

3.1. LCA Results

The LCA results were calculated using eFootprint, modeling 1 unit (a pair of US6 women's sport sandals). Key results include:

Impact Category	Unit	LCA Result
GWP-2021	kg CO ₂ eq.	11.0184
PED	MJ	93.9875
ADP	kg Sb eq.	0.0000487
WU	kg	18889.90
AP	kg SO ₂ eq.	0.03855
EP	kg PO ₄ ³⁻ eq.	0.00795
RI	kg PM2.5 eq.	0.00997
ODP	kg CFC-11 eq.	1.44E-07
POFP	kg NMVOC eq.	0.00452

3.2. Cumulative Contribution Analysis

This analysis evaluates the direct and upstream contributions of each process to the overall LCA results.

Process	GWP - 2021	PED	ADP	WU	AP	EP	RI	ODP	POFP
US6 Women's Sport Sandals	11.0 2	93.9 9	4.87E -05	1.89E+0 4	0.0 4	7.95E -03	9.97E -03	1.44E -07	4.52E -03

4. Life Cycle Interpretation

4.1. Assumptions and Limitations

The assumptions for each unit process model are detailed in the following table:

Process Name	Assumption Analysis
US6 Women's Sport Sandals [Production]	-

4.4. Conclusion and Recommendations

(Provide key findings and suggestions for improvement.)

